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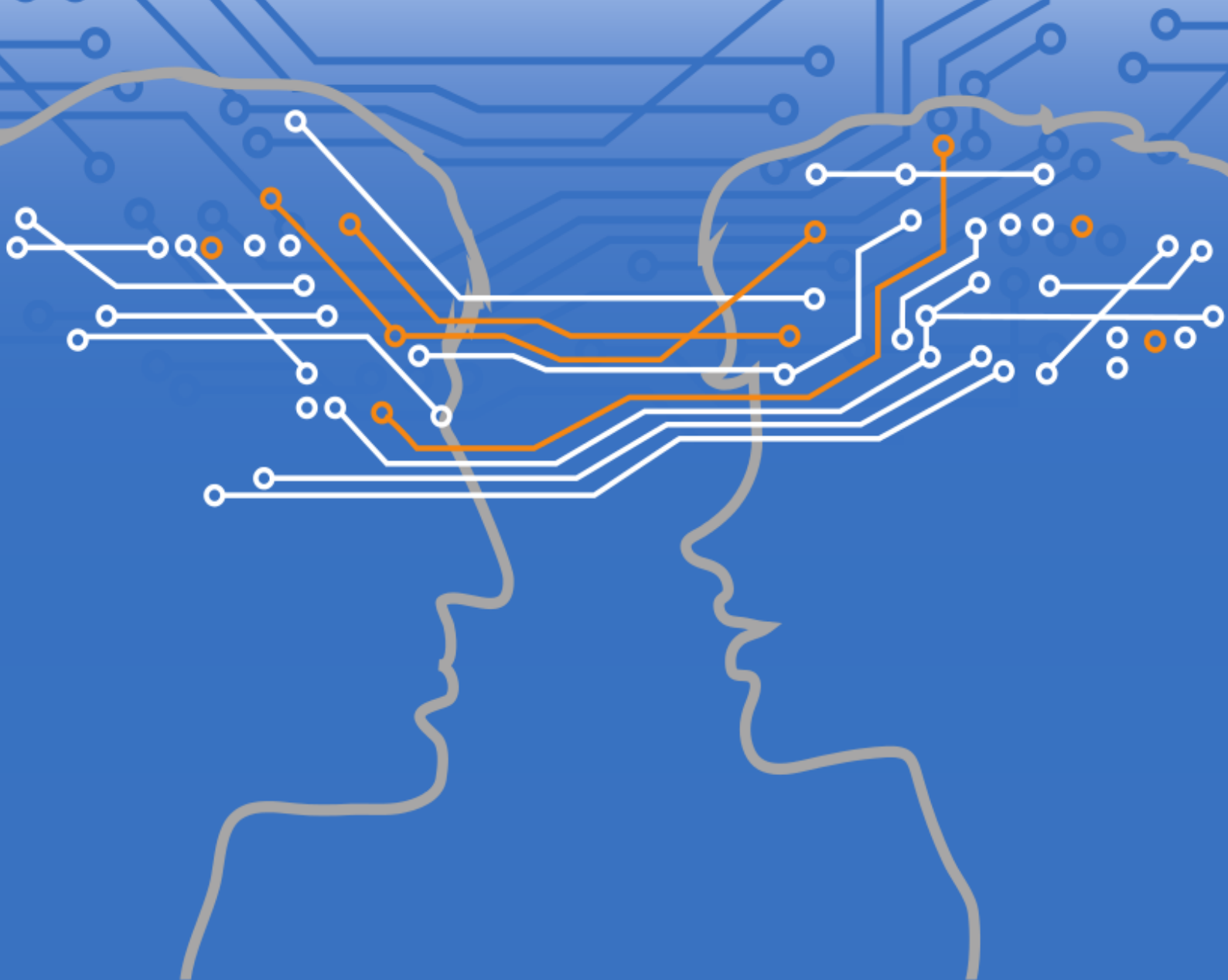
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Proceedings of the 4th Workshop on Awareness and Reflection in Technology-Enhanced Learning

In conjunction with the 9th European Conference on Technology-Enhanced Learning: Open Learning and Teaching in Educational Communities

Graz, Austria, September 16, 2014

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Awareness and reflection in technology enhanced learning

Awareness and reflection can be viewed from the differing perspectives of the disciplines informing Technology-Enhanced Learning, such as Psychology, Educational and Learning Sciences, or Computer Science.

A common denominator can be identified, though, and enhancing 'awareness' of learners and other participants involved in learning processes by technology means augmenting formal or informal learning experiences, typically in real-time, with information on progress, presence, outcomes, workspace, and the like. Supporting 'reflection' then means enabling learners to capture, adapt, re-evaluate, and share experience in anticipation of future situations it will prove relevant to. Reflection supported digitally is a creative act, adding sense and meaning to experiences made.

Combining support for "awareness" and "reflection" bears huge potential for improving the learning and training with respect to utility, self-regulation, usability, and user experience.

The ARTEL workshop series brings - for the 4th time in 2014 - together researchers and professionals from different backgrounds to provide a forum for discussing the multifaceted area of awareness and reflection.

For this year 2014, the workshop organizes discussion and meta-reflection amongst researchers around the application of awareness and reflection in practice, its impact on learners and questions of feasibility, and sustainability for awareness and reflection in education and work. This year's workshop theme is:

How does computer-support for awareness and reflection need to be embedded into practical (working or learning) contexts in order for learners to benefit from such computer support?

Summary of the contributions

The #ARTEL14 workshop accepted 4 full papers, 1 short paper, and 4 demo papers. The accepted papers discuss awareness and reflection in diverse settings, such as blue-collar jobs and white-collar jobs, working in small enterprises, or learning at university level.

As for the full papers, Maurizio Megliola, Gianluigi Di Vito, Roberto Sanguini, Fridolin Wild, and Paul Lefrere discuss in "Creating awareness of kinaesthetic learning using the Experience API: current practices, emerging challenges, possible solutions" an interface specification for capturing in particular kinaesthetic learning experiences. The authors also discuss a taxonomy of verbs describing handling and motion. Kinaesthetic skills are in demand for instance in the manufacturing or maintenance sectors. The captured learning experiences can be utilised to generate feedback to the learner.

Fridolin Wild, Peter Scott, Paul Lefrere, Jaakko Karjalainen, Kaj Helin, Ambjorn Naeve, and Erik Isaksson situate their work "Towards data exchange formats for learning expe-

periences in manufacturing workplaces” in the manufacturing sector. This work models the experiential and reflective learning process with a view on creating data exchange formats, also discussing the necessity to - formally - talk about actions in the real world as a complement to actions performed in virtual environments.

Andreas Janson, Sissy-Josefina Ernst, Katja Lehmann, and Jan Marco Leimeister have as background for their work in ”Creating awareness and reflection in a large-scale IS lecture - the application of a peer assessment in a flipped classroom scenario” university learning in large-scale lectures (much more learners than instructors). They discuss computer-supported peer assessment as possibility to induce reflection on learning content. In contrast to the previous two works, this contributions focusses mostly on cognitive instead of motoric competences.

Angela Fessl, Gudrun Wesiak, and Granit Luzhnica showcase in ”Application overlapping user profiles to foster reflective learning at work” the potential benefits of collecting activity logging data from multiple applications in a single user profile application. This work is set on the background of white-collar knowledge workers, with desktop- and web-based activity logging.

In their short paper, Michael Prilla, Oliver Blunk, Jenny Bimrose, and Alan Brown discuss in ”Reflection as support for career adaptability: A concept for reflective learning in public administration” reflection as learning mechanism to support professional identity change as a means for organisational change in the context of public employment services.

The four demo papers are started off by the contribution by Milos Kravcik, Kateryna Neulinger, and Ralf Klamma, in which the authors showcase widget-based personal learning environments for ”Boosting informal workplace learning in small enterprises”.

Nils Faltin, Simon Schwantzer, and Margret Jung present the ”Activity recommendation app - software to evaluate the usefulness of improvement recommendations created in a team”.

Min Ji, Christine Michel, Elise Lavoue, and Sebastien George demonstrate the ”DDART: an awareness system to favor reflection during project-based learning”.

Last, but not least, Sven Charleer, Jose Luis Santos, Joris Klerkx, and Erik Duval present the ”LARAe: Learning Analytics Reflection & Awareness environment”.

Awareness and reflection workshop series

The official workshop webpage can be found at <http://teleurope.eu/artel14>

The 4th Workshop on Awareness and Reflection in Technology-Enhanced Learning (AR-TEL 2014) is part of a successful series of previous workshops.

- 3rd Workshop on Awareness and Reflection in Technology-Enhanced Learning (AR-TEL13). Workshop homepage: <http://teleurope.eu/artel13>. Proceedings: <http://ceur-ws.org/Vol-1103/>.

- 2nd Workshop on Awareness and Reflection in Technology-Enhanced Learning (ARTEL12). Workshop homepage: <http://www.teleurope.eu/artel12>. Proceedings: <http://ceur-ws.org/Vol-931/>.
- 1st European Workshop on Awareness and Reflection in Learning Networks (ARNets11). Workshop homepage: <http://teleurope.eu/arnets11>. Proceedings: <http://ceur-ws.org/Vol-790/>
- Augmenting the Learning Experience with Collaborative Reflection (ALECR11). Workshop homepage: <http://www.i-maginary.it/ectel2011/index.html>
- 1st Workshop on Awareness and Reflection in Personal Learning Environments (ARPLE11). Workshop homepage: <http://teleurope.eu/arple11>. Proceedings: http://journal.webscience.org/view/events/The_PLE_Conference_2011/paper.html#group_Proceedings_of_the_1st_Workshop_on_Awareness_and_Reflection_in_Personal_Learning_Environments

To stay updated about future events, to share your research, or simple to participate with other researchers, consider joining the group about Awareness and Reflection in Technology-Enhanced Learning:

<http://teleurope.eu/artel>

We especially would like to thank the members of the programme committee for their invaluable work in scoping and promoting the workshop and quality assuring the contributions with their peer reviews.

September 2014

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Supporting FP7 projects



<http://www.mirror-project.eu>



<http://learning-layers.eu>



<http://www.tellme-ip.eu>



<http://wespot-project.eu>



<http://employid.eu>



<http://www.boost-project.eu>



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Creating awareness of kinaesthetic learning using the Experience API: current practices, emerging challenges, possible solutions

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Abstract. We describe our use of the Experience API in preparing blue-collar workers for three frequently arising work contexts, including, for example, the requirement to perform maintenance tasks exactly as specified, consistently, quickly, and without error. We provide some theoretical underpinning for modifying and updating the API to remain useful in near-future training scenarios, such as having a shorter time allowed for kinaesthetic learning experiences than in traditional apprenticeships or training. We propose ways to involve a wide range of stakeholders in appraising the API and ensuring that any enhancements to it, or add-ons, are useful, feasible and compatible with current TEL practices and tools, such as learning-design modelling languages.

Keywords: Experience sharing, xAPI, verbs.

1 Introduction

Apprenticeship today often includes the development of ‘kinaesthetic intelligence’, i.e. the tactile (physical) abilities associated with using the body to create (or ‘do’) something involving highly coordinated and efficient body movements. Prototypical examples of this can be found in the fluid and precise motions of skilled dancers, surgeons, and skilled blue-collar workers. Gardner (2011) links high bodily-kinaesthetic intelligence to “control of one’s bodily motions, the capacity to handle objects skillfully, a sense of timing, a clear sense of the goal of a physical action, along with the ability to train responses”.

Becoming a skilled kinaesthetic performer through traditional apprenticeship is today largely conceptualised to take years, but this golden age of long-cycle training is quickly disappearing. Professional training environments such as in manufacturing face the challenge that the world of repetition that enabled long cycles of training to be cost-justified is increasingly taken over by short-run or personalised production,

using advanced factory machinery that does not require physical dexterity (including teachable robots that can emulate dextrous production-line workers), thereby not only causing shifts in the demand for skills, but at the same time downsizing the economically acceptable time-to-competence.

Achievements in interoperability for technology-enhanced learning (TEL) over the last decade are making it viable to develop TEL-based alternatives to a traditional apprenticeship. For example, TEL is making it possible to author, exchange, and then orchestrate the re-enactment of learning activities across distributed tools, using learning process and learning design modelling languages (Laurillard & Ljubojevic, 2011; Fuente Valentín, Pardo, & Degado Kloos, 2011; Mueller, Zimmermann, & Peters, 2010; Koper & Tattersall, 2005; Wild, Moedritscher, & Sigurdarson, 2008).

What these modelling languages fall short of, however, is the ability to handle hybrid (human-machine) experiences, to teach machines, or to train people at a distance – as required, for example, in workplaces that include robots or software agents, or in workplaces that include distributed participation across companies in a supply chain. In particular, when it comes to bridging between the virtual and the real world, between digital and physical experiences, present means are ill equipped for supporting the capturing, codification, and sharing of hybrid learning experiences.

Moreover, TEL-focused ways of capturing performance and collecting good practice are as of today still resource-intensive, placing a barrier to the spread of innovation and hindering resilience of business.

That barrier can be somewhat reduced through the use of the present version of the Experience API (ADL, 2013), and we claim could be further reduced through possible extensions and complements to the API, the need for which has become apparent in the TELLME project.

The Experience API is a novel interface specification designed to link sensor networks together to enable the real-time collection and analysis of learning experiences conducted in different contexts, with the aim of providing better interoperability between the different types of participating educational systems and devices. Being precondition to mining and modelling, it forms a centrepiece in the canon of next generation techniques and technologies for capturing, codification, and sharing of hybrid learning experiences.

This paper presents an overview of how the components and concepts of the Experience API are integrated within the TELL-ME project to foster tracking and analysis of learning and training in three different manufacturing environments, namely Aeronautics, Furniture, and Textiles.

We describe within this contribution, how we deploy an open source Learning Recording Store to allow for collecting and reporting learning across the various components of the TELL-ME system. Moreover, starting with the Aeronautics industry, we define a taxonomy of verbs of handling and motion for capturing in particular kinaesthetic learning experiences as required in the helicopter industry, when targeting learning about a defined helicopter model and the connected standard maintenance procedures.

2 TELLME Learning Locker

The ADL Experience API (short ‘xAPI’)¹, formerly known as TinCan API, is an extension of the Activity Streams² specification, a format for capturing activity on social networks, created by companies like Google, Facebook, Microsoft, IBM etc., that allows for statements of experience to be delivered to and stored securely in a Learning Record Store (LRS). These statements of experience are typically learning experiences, but the API can address statements of any kind of experiences a person immerses in, both on- and offline.

While the core objects of an xAPI statement (Actor, Verb and Object) derive from the core Activity Streams specification, the Experience API has many more defined constructs for tracking information pertinent for the learner (with captured results such as “score”, “success”, “completion”, “attempt”, and “response”), unlike the Activity Streams spec which focuses on the publisher.

In its most basic application, the Experience API allows one system (the activity ‘provider’) to send a message (also known as the ‘statement’) to another system (aka the ‘Learning Record Store’) about something a user has done. Up until now, this process has mostly taken place inside the organisation’s Learning Management System. Anything we wanted to track had to be built as part of the LMS functionality, or needed tailor-made integration. The Experience API now allows sending and receiving data between systems about what someone has done in a more openly defined way (see Figure 1).

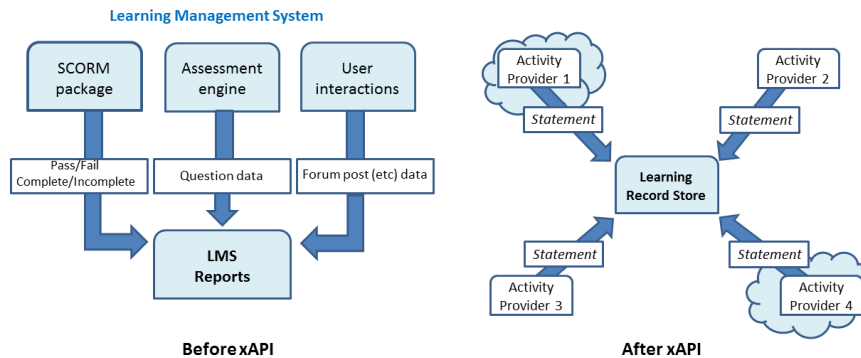


Figure 1. The experience tracking before and after the advent of the xAPI.

This is important, because via the Experience API, any system can send xAPI statements using a standard connection method. This process of sending xAPI statements can happen in systems behind the firewall or openly across the Internet using secure connections.

¹ <http://www.adlnet.gov/tla/experience-api/>

² <http://activitystrea.ms/>

Within TELL-ME, we have implemented an instance of the open-source Learning Locker³ Learning Record Store, a LAMP-based project using MongoDB, PHP, and AngularJS, to begin collecting learning activity statements generated by xAPI compliant learning activities and reporting on such data.

The REST WS interface to the LRS was made available to be used by any component of the TELL-ME architecture to submit and retrieve xAPI statements. An example of such xAPI triple submission (with POST), using curl⁴, is shown below:

```
curl -X POST --data @example.json -H "Content-Type: application/json" --user 465ea716cebb2476fa0d8eca90c3d4f594e64b51:ccbdb91f75d61b726800313b2aa9f50f562bad66 -H "x-experience-api-version: 1.0.0" http://demos.polymedia.it/tellme/learninglocker/data/xAPI/statements
```

The example above is parameterized by a reference to a JSON file named `example.json`: it contains the actual xAPI statement in form of an actor-verb-object triple:

```
{
  "actor": {
    "objectType": "Agent",
    "name": "Gianluigi Di Vito",
    "mbox": "mailto:gianluigi.divito@piksel.com"
  },
  "verb": {
    "id": "http://activitystrea.ms/schema/1.0/watch",
    "display": {
      "en-US": "Watched"
    }
  },
  "object": {
    "id": "http://tellme-ip.eu/media/video/152"
  }
}
```

Once statements are logged, they can be queried again, for example, as needed for constraint validation to check, whether a user actually performed a certain required action step – then requiring additional constraint checker components.

³ <http://learninglocker.net/>

⁴ curl - command line tool for transferring data with URL syntax: <http://curl.haxx.se/>

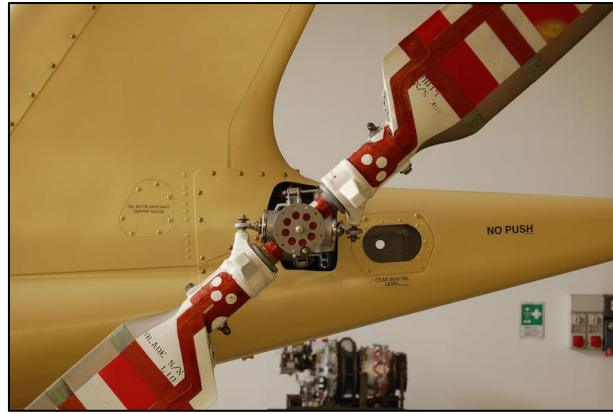


Figure 1. Learner interaction during maintenance of a helicopter tail rotor: ‘user *cleaned* corrosion inhibitors’.

Same as any LRS implementation, the LearningLocker integrates data from multiple systems. The ‘Activity Provider’ can be any sort of system, where the user performs learning activity. Examples of such systems include search engines, social bookmark engines, proxy servers, social networking platforms, webinars, blogs, CRMs, as well as specific additional TELL-ME components. An example of the latter is the TELL-ME smart player application under development, which can drop statements about a user consuming a video (to the end or just the access of it). Another example is ARgh!, the platform for the delivery of context-based Augmented Reality content on mobile devices at the workplaces, which can drop statements about certain action steps being executed by the learner: Figure 1 shows an example of such user interaction with physical objects during training.

Integrating the Experience API requires not only providing an LRS, but also defining the set of ‘predicates’ for logging the experience statements in a meaningful way. The ADL features a standard list of commonly occurring verbs⁵. This list, however, is not bespoke to manufacturing and is restricted too much to generic, web-based learning activity, excluding interaction with objects of the real world – as required for learning by experience in manufacturing. The same is the case for ADL’s extended list of “Proposed Verbs for the Experience API”⁶. Once data are mapped to the elements of the Experience API statement (see Section 3), they can be captured in the learning record store.

Figure 3 shows examples of such statements stored in the Learning Locker coming from the ARgh! trials.

⁵ <http://adlnet.gov/expapi/verbs/>

⁶ <http://bit.ly/1zGmAzn>

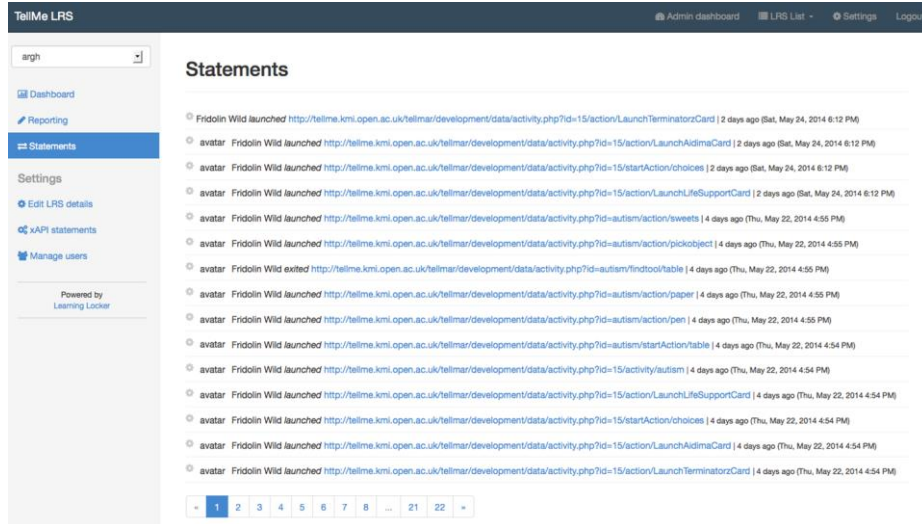


Figure 2. Argh! statements stored in the Learning Locker

The Learning Locker also allows creating personalized queries by means of its reporting functions, combining data from both learning activities and workplace performance, allowing linking of learning activity to performance.

One important aspect to be considered is the handling of security and the protection of the privacy of learners. In the Experience API, authentication is tied to the user, not the content. The user can be any person or thing that is asserting the statement. The user can be a learner, an instructor, or even a software agent and it can authenticate with OAuth⁷, a commonly used access delegation mechanism employed by many big names such as Google, Facebook, Salesforce, etc. that eliminates the needs of sharing passwords between applications to exchange data. In this aim, the Learning Locker supports authentication and it is integrated with OAuth 2.0, exposing an API which allows 3rd parties to connect to the API via OAuth 2.0.

⁷ <http://oauth.net/>

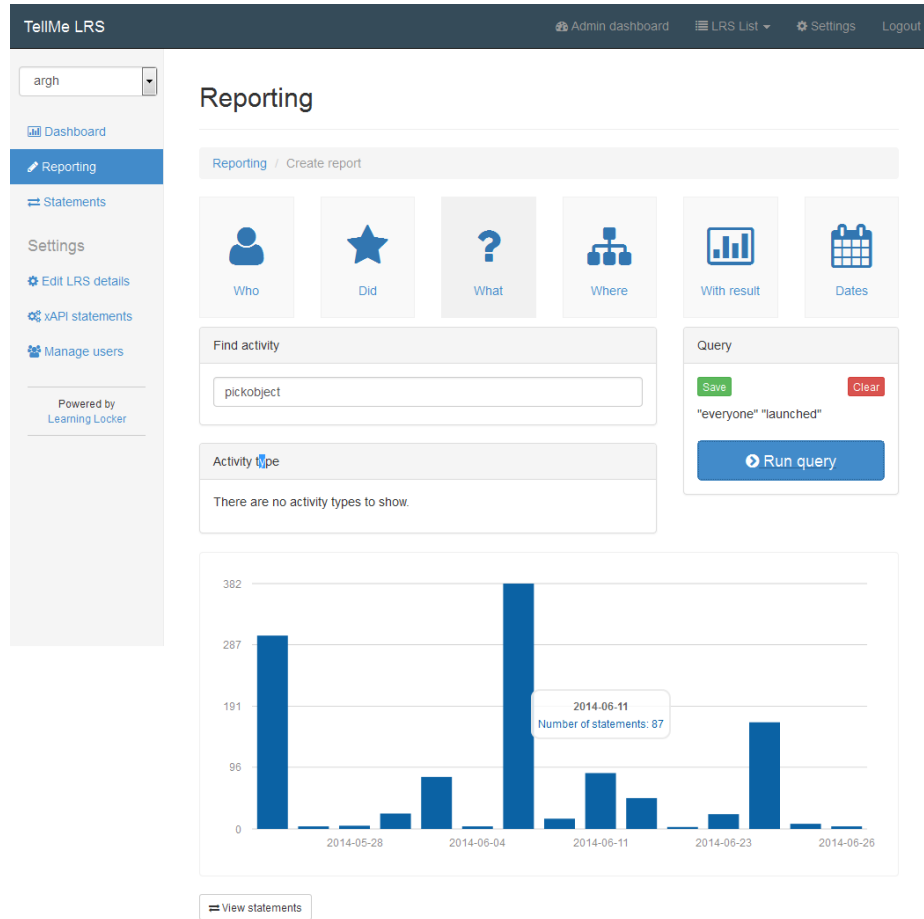


Figure 3. Learning Locker Reporting page

3 The <S,P,O> statement vocabulary (Aeronautics industry)

Each xAPI statement follows the syntax of providing a subject, predicate, and object. While subjects and objects can vary, predicates (the ‘verbs’) are ideally rather slowly changing and can be defined in advance.

From a cognitive linguistic perspective, there is prior work on defining verbs of motion and handling – and clarifying their relation to the way humans’ cognitively process them. Roy (2005) explains how humans learn words by grounding them in perception and action. The presented theories are tested computationally by implementing them into a series of conversational robots, the latest of which - Ripley - can explain "aspects of context-dependent shifts of word meaning" that other theories fall short of. To construct a vocabulary of verbs that is widely understood, easy to learn, and natural in mapping, the work of Roy provides valuable insights: Roy postulates

that "verbs that refer to physical actions are naturally grounded in representations that encode the temporal flow of events" (p. 391). She further details that the grounding of action verbs follows the schema of specifying which force dynamics (out of a limited set) apply and which temporal Allen relations operate (p. 391). Any higher-level composition of action verbs, so Roy (p.392), can be traced back to and expressed in terms of these fundamental temporal and force relations.

This provides an angle for defining and structuring the TELL-ME taxonomy of verbs of handling and motion: it provides a basis for ordering from fundamental to composite actions, also defining their similarities. Moreover, it offers insights on how to map these verbs back to perception: it provides a rationale for how many visual overlay elements are required for an augmented reality instruction to express a certain motion verb primitive. For example, a verb 'pick up' requires the overlay visualisation of a grabbing hand as well as a highlight of the object to be picked up, whereas the motion verb 'move' consists of both 'pick up' and 'put down' actions, thus requiring more visual elements to be specified.

Palmer et al. (2005) further discuss the "criteria used to define the sets of semantic roles" for building verb classes. It provides insights into the argument structure of framesets (and so-called role-sets) of verb classes (Palmer et al., 2005, section 3).

Chatterjee (2001) reviews the cognitive relationship between language and space. He refers to Jackendoff in postulating that the "conceptual structure of verbs decomposes into primitives such as 'movement', 'path' and 'location' (p.57).

From an augmented reality perspective, there is additional prior work of relevance. Robertson and MacIntyre (2009) provide a review of the state of the art in displaying communicative intent in an AR-based system. The proposed taxonomy, however, stays on a level of general applicability across all sorts of augmented reality applications and is lacking the level of handling and motion required for a particular workplace, such as required in learning the maintenance of helicopters. The proposed categories (called 'style' strategies) are 'include', 'visible', 'find', 'label', 'recognizable', 'focus', 'subdue', 'visual property', 'ghost', and 'highlight' (p.149f). The communicative goals signified by these styling operations for visual overlays are listed as 'show', 'property', 'state', 'location', 'reference', 'change', 'relative-location', 'identify', 'action', 'move', and 'enhancement' (p.148). Other than the work in cognitive linguistics, here, the focus is clearly defined from a technical and not user angle: helping the user to identify or move an object is on the same level as setting labels.

In the aeronautical field, maintenance operations must be carried out according to official documents issued by the design authority of the aircraft. Such document is called the Maintenance Publication. Usually, it is organised inside the Interactive Electronic Technical Publication (IETP). The AECMA S1000D (European Association of Aerospace Constructors S1000D) is an international standard for development of IETP, utilizing a Common Source Data Base (CSDB). The standard prescribes rules to name, define, and code everything that is necessary to carry out maintenance activities in terms of:

- aircraft model;
- systems and subsystems of the aircraft;
- maintenance tasks;

- location of components;
- tools;
- additional documentations;
- miscellaneous.

Every maintenance task is identified by a unique code referring to the Task Category (e.g. 'servicing', 'repairs', 'package'), the Maintenance Activity within the category ('drain', 'fill', 'remove', 'clean', etc.), and - finally - to the definition which gives the procedure and data necessary to carry out maintenance tasks on a specific system or component. The code allows retrieving both procedures and data necessary to e.g. fill containers with fuel, oil, oxygen, nitrogen, air, water, or other fluids.

For the TELL-ME taxonomy of verbs of handling and motion the following preliminary list was compiled by pilot partners, see Table 1. The initial taxonomy presents the verbs of handling and motion as required in the helicopter industry for a defined helicopter model and the connected standard maintenance procedures. All the actions are handled by the actor 'certified staff', which therefore has not been included in the table.

Activity	Verb	Objects
Operation	Loaded	Cargo
	Unloaded	Cargo
Servicing	Filled	Liquid or gas (fuel, oil, oxygen, nitrogen, air, water).
	Drained	Liquid (fuel, oil, water).
	Released (pressure)	Gas (oxygen, nitrogen).
	Lubricated	System, equipment, component, or item.
	Cleaned	Surface
	Applied (protection)	Surface
	Removed (ice)	Surface
	Adjusted	System, equipment or component.
	Aligned	System, equipment or component.
	Calibrated	System, equipment or component.
	Inspected (keep serviceable)	Product, system, equipment or component.
	Changed	Liquid (fuel, oil, water).
		Gas (oxygen, nitrogen).
Examination, tests and checks	Examined (visual)	Product, system, equipment, component equipment, component, or item.
	Tested (operation / function)	System, equipment or component.
	Tested (function)	System, equipment or component.
	Tested (structure)	Structure
	Designed (data /	System, equipment, or component.

	tolerance check)	
	Monitored (condition)	Product, system, equipment or component.
Disconnect, remove and disassemble procedures	Disconnected	Equipment, components, or items.
	Removed	Equipment, components, or items.
	Disassembled	Equipment, components, or items.
	Opened for access	Panels or doors (engine bay doors, landing gear doors, etc.).
	Unloaded (download software)	Items.
Repairs and locally make procedures and data	Added material	Product, equipment, component or item.
	Attached material	Product, equipment, component or item.
	Changed (mechanical strength / structure of material / surface finish of material)	Structure, surface.
	Removed	Material
	Repaired	Damaged product, system, equipment or component.
Assemble, install and connect procedures	Assembled	Equipment, components and items.
	Installed	Equipment, components and items.
	Connected	Equipment, components and items.
	Closed after access	Panels or doors (engine bay doors, landing gear doors, etc.).
	Loaded (upload software)	Items.
Package, handling, storage and transportation	Removed from (preservation material)	Products, systems equipment or components,
	Put (in container)	Item.
	Removed (from container)	Item.
	Kept serviceable (when in storage)	Products, systems, equipment, or components.
	Moved (when in storage)	Products, systems, equipment, or components.
	Prepared for use (after storage)	Item

Table 1. Activities and their predicates (plus objects).

4 Conclusion and outlook

In this contribution, we have presented an overview of how the concepts of Experience API can be applied in a manufacturing environment, precisely in the Aeronautics industry. In the context of the TELL-ME project, three different taxonomies of verbs of handling and motion were prepared or are currently being prepared by the pilot partners, one of which has been described in this paper (from the helicopter industry). An instance on the open-source Learning Locker Learning Record Store was made available to any TELL-ME component, allowing them storing and retrieving xAPI statements about the workers activities.

For the future development, we intend to add preliminary taxonomies for the other two industry sectors, further mature them, and address issues related to the analytics and statements interpretation, going further ahead in understanding data and how to find meaning from it (with the help of statistical analysis). In addition, we plan to explore how to extend (keyword: ‘constraint checker’) or complement the Experience API to handle emerging challenges such as the need to consider the ergonomics and learning needs of human-robot workspaces. This will involve conversations and collaborations with multiple stakeholders, such as TEL vendors and users, standards bodies, and participants in robotics projects and projects involving or affected by automation – as envisioned for the Factory of the Future projects.

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Towards data exchange formats for learning experiences in manufacturing workplaces

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Abstract. Manufacturing industries are currently transforming, most notably through the introduction of advanced machinery and increasing degrees of automation. This has caused a shift in skills required, calling for a skills gap to be filled. Learning technology needs to embrace this change and with this contribution, we propose a process model for learning by experience to understand and explain learning under these changed conditions. To put this process into practice, we propose two interchange formats for capturing, sharing, and re-enacting pervasive learning activities and for describing workplaces with involved things, persons, places, devices, apps, and their set-up.

Keywords: Experience sharing, activity model, workplace model, awareness, augmented reality.

1 Introduction

The European (and global) manufacturing industry is currently undergoing significant transformation and will continue to change over the coming years. Intrinsically, the increasing presence and ability of robots and advanced machinery in production lines with their enhanced senses and increased dexterity (Frey & Osborne, 2013, p.38) are what triggers this shift, bringing along rising degrees of computerisation of jobs (ditto) and allowing for delocalisation of production.

Extrinsically, this transformation has started to cause a significant skills gap in the EU (and globally) with – on the one side – the highest overall unemployment rates observed in more than a decade (Eurostats, 2014; EC, 2013c, p. 2), especially amongst young people (EC, 2013b; EC, 2013d), and an ever increasing risk of redundancy for low and medium skilled workers in production.

On the other hand, several hundred thousand jobs in the EU remain unfilled, as there is a shortage in highly skilled personnel in manufacturing (EC, 2013a, p.10). Forecasts predict that this skills gap is likely to widen in coming years up to 2020

(McKinsey, 2012, p. 45). In fact, manufacturing is currently one of the three sectors hit most hard by this skills shortage in the EU (EC, 2013c, p. 5). Formal secondary and tertiary education haven’t managed to create and won’t succeed in producing the supply required, neither in numbers, nor with respect to matching skills profiles. Moreover, high attrition rates in education have further eroded the foundation.

Technology enhanced learning has the potential to play an important role in overcoming this existing skills gap in manufacturing – when applied effectively and when motivating the development of competences in key areas required through the capturing and re-enactment of learning activities.

Within this contribution, we first define a learning process model that is capable of integrating classical (learning content oriented) and novel pervasive (Augmented Reality and Internet of Things oriented) elements in learning at manufacturing workplaces. From there, we introduce a proposal for an activity modelling language (activityML) for representing activity descriptions required in augmented reality enabled learning experiences. Moreover and in section 4, we introduce the needed workplace modelling language (workplaceML), which can be used to describe the tangibles (things, places, persons), configurables (apps, devices), and triggers (detectables, overlays) of a particular workplace. We relate our work to precursors in Section 5 to then wrap up the paper with an outlook and open research challenges.

2 Process model of learning by experience

New skills for new jobs not only demand an enhancement of the deep professional skills to achieve a ‘master level of performance’, but also necessitate development and upgrading of competence to innovate, for lifelong learning, and for learning through social interaction (Wild et al., 2013, p. 12f).

Achieving a master level of performance and developing competence to innovate in the sense of building up “the ability to generate ideas and artefacts that are new, influential, and valuable” (FET, 2011) are – at least in manufacturing and at least for small and medium enterprises – very closely intertwined.

	Tacit	Explicit
Tacit	<i>Socialisation</i>	<i>Externalisation</i>
Explicit	<i>Internalisation</i>	<i>Combination</i>

Table 1. Knowledge conversion modalities.

Similarly, the other two, namely lifelong learning and social learning competence, both pay tribute to the observation that “people carry and create knowledge” and that “any company knowledge management strategy must rely primarily on people, and support [of] the knowledge creation chain” (Krassi and Kiviranta, 2013, p.29). Both of them aim to facilitate “bi-directional tacit-explicit knowledge conversion” (Nonaka, 1994, p.19) along the four modalities listed in **Table 1**: externalisation (tacit-to-

explicit), internalisation (explicit-to-tacit), socialisation (tacit-to-tacit), and combination (explicit-to-explicit).

While ‘competences’ are typically defined to subsume knowledge, skills and other abilities, in the context of manufacturing – as the word already suggests – motoric and artistic skills require special attention. Kinaesthetic learning elements relate in manufacturing environments to controlling own body movement and handling objects skillfully and timely (cf. Gardner, 1984: bodily-kinaesthetic intelligence).

With the rise of Wearable Computing, the Internet of Things, and Augmented Reality, capturing and observing kinaesthetic performance becomes possible in a fundamentally different way, as, for example, pioneered in the fitness and health sector.

Reflective learning processes that cater for kinaesthetic and non-kinaesthetic elements can be broken down into five distinct process steps: enquire, mix, experience, match, optimise (Wild et al., 2013, p.29ff). The steps do not necessarily prescribe a single route and order, in which they should be taken, but are interconnected as indicated in **Fig. 1**: it is a cyclical model with built-in support for experience tracking, analytics, and guidance, supporting flexible mixes and dynamic optimization for on- and off-the-job workplace learning.

Fig. 1 depicts the individual steps of this process model: at its core, blue-collar workers *experience* learning in an episodic way (on and off the job). Experiencing thereby relates to both re-enacting explicit learning activities as well as engaging in open innovation activities.

Experiencing learning tightly interacts with *enquiry*: whenever novel needs arise or (wicked) problems are encountered on the job, the enquiry step supports the user in identifying relevant learning opportunities (such as gaps in knowledge, new learning opportunities arising, etc.). In parts, this relates to navigational positioning support in the workplace reference space’s skills taxonomy to clearly determine the competence sought after. This, however, also relates to supporting discovery beyond existing or – particularly relevant for SMEs – so-far tacit knowledge.

Through tracking of experiences made, potential competence gaps (ignorance) can be uncovered, uncovering thereby either supported by the system in the *matching* step (see below; aiming to help unveil shortcomings the user is unaware of) or – proactively, where awareness is given – through user enquiry.

Once needs or problems are identified, the *mixing* step comes into play: here, the learner is supported in selecting relevant existing mixes or creating new and adapting existing mixes. While standard problems have standard solutions, smart factories enable their workers to rapidly compile mixes that satisfy needs, but at the same time ensure documentation of knowledge, where it is created. Such mix is essentially a serialized, activity-focused representation of the specific workplace and the jobs to be enacted within it, instantiating an abstract workspace to a level of concreteness where actions are named, locations resolved, and objects as well as tools uniquely identified.

Moreover, the activity mix models validation constraints, by which the *matching* step can determine whether there is evidence that the user actually performed the action steps as required. Constraints model learning flows including exception handling. The constraint-matching step picks up on strategic performance indicators and their defined tolerance boundaries set at design time, and connects them to the ob-

served operational performance as tracked by the *experience* step. Reports for performance analytics can be generated live, condensing performance records (from an xAPI endpoint; ADL, 2013) into comprehensive reports, potentially contrasting performance of individuals with (de-identified) benchmarks.

Optimisations then take such analytics data and performance benchmarks to recommend repetition, alternative resources, or even a change of path.

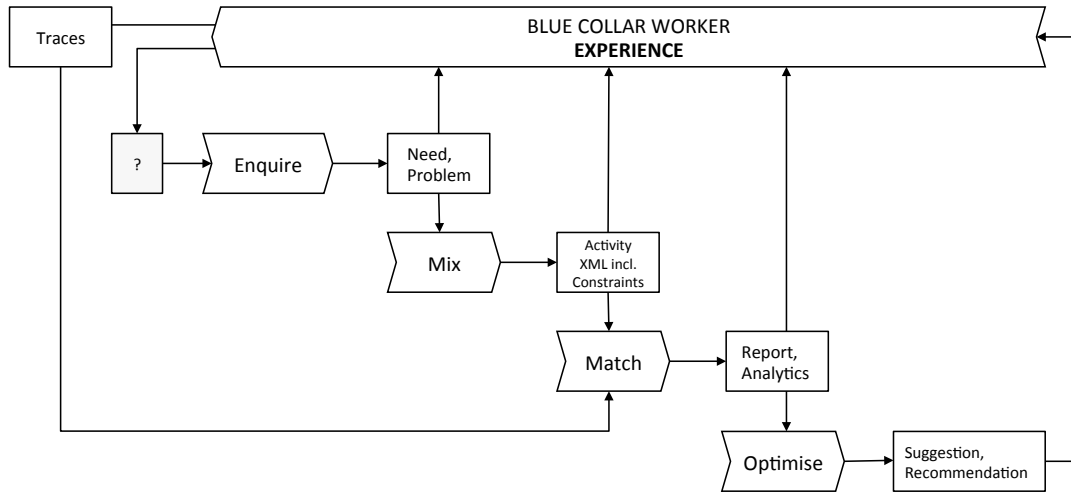


Fig. 1. Process model for learning by experience.

The bi-directional conversion between tacit and explicit knowledge is modelled in the process loops between the big process step ‘experiencing’ and the smaller ones ‘enquiry’, ‘mix’, ‘match’, and ‘optimise’: explication converts tacit knowledge to explicit as indicated by the outputs ‘traces’, ‘needs’, ‘activity mixes’, ‘analytics reports’, and ‘recommendations’. When such outputs are used to scaffold a learning experience, they are internalised. Remixing combines existing knowledge, and tracking and evidence recording helps with converting tacit to explicit knowledge. Moreover, activity mixes can involve socialisation and social sharing.

3 Modelling activities

A common representation format is key requirement for an efficient exchange of activity mixes. What makes it particularly challenging to define activity mixes in a process for learning by experience is that it requires not only orchestrating user interaction across multiple devices within a single activity, but also integrating the tracking of and reacting to user interaction across these devices and – even more so – their different sensors. Validating that the user actually did something (like moving to a particular location or like picking up a particular object in the real world), requires specifying validation constraints that can be checked and that express *which* soft- and

hardware sensors have to pick up on *what* user (or app) behaviour. For this we propose activityML (activity modelling language), an XML dialect.

Fig. 2 provides an overview on the conceptual model of activityML. **Fig. 3** adds an example activityML file. The root node is ‘activity’. Each activity needs to specify the URL of the workplace description file, a name, and the language (in addition to the unique activity id). The activity is then broken down into ‘action’ steps, each of them being a self-contained unit, describing ‘summons’ for action chaining, ‘constraints’ for action validation, and ‘messages’ for communication, as well as ‘instruction’ to be shown or the ‘app’ (widget or app) to be launched.

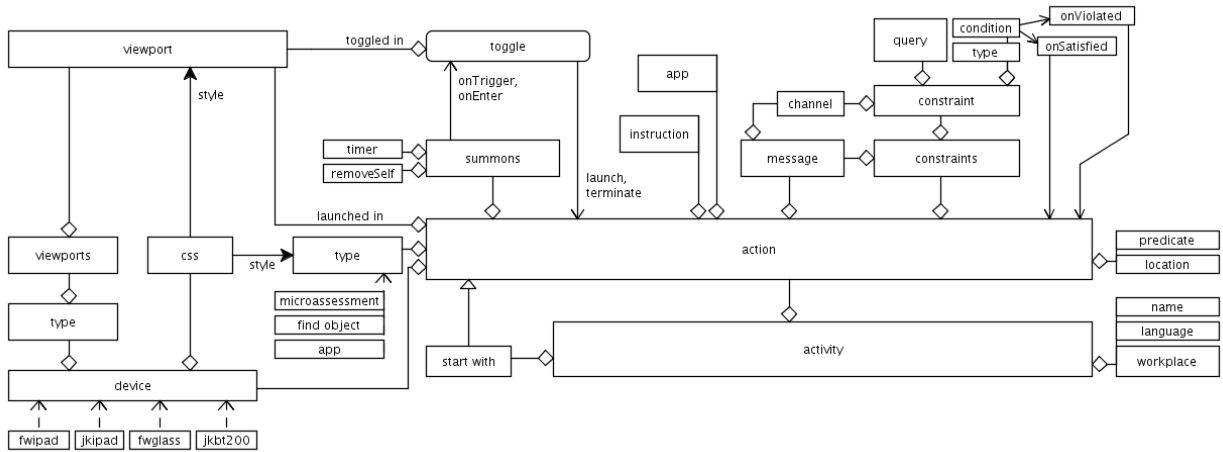


Fig. 2. Conceptual model of the activityML.

Moreover, styling information is linked using cascading style sheets over the action ‘type’ and the ‘device’ and its ‘viewports’ defined. Currently, there are three viewports defined: ‘objects’, ‘actions’, and ‘reactions’. They refer to particular areas of the screen reserved for inserting actions and the related display data.

Each ‘action’ has a ‘predicate’, which is the verb required for inserting trace statements to the xAPI (ADL, 2013) tracking endpoint. Each action can optionally specify a ‘location’, i.e. a defined ‘place’ of the workplace model, in which it shall happen.

Chaining of actions is modeled through specifying for each action, which other actions it ‘summons’ – either when launching the action (‘onEnter’) or when events are triggered (‘onTrigger’). The Boolean ‘removeSelf’ decides on whether the action is removed from the viewport or sustained when the summons are executed. A timer can be set to automatically trigger summons after a given interval (in milliseconds). Summoning an action twice will first show, then remove it from the viewport (hence ‘toggle’). Each summoned toggle specifies the ‘viewport’ in which it is toggling an action. The summons are also used to activate in a context-dependent way the ids of actions relevant for the next step. By using the id of a tangible (e.g. thing or person) as the id of an action step, for example, an object detection engine can trigger the launching (or termination) of the according action.

The ‘constraints’ define, how the system can validate that certain user interaction and other observable conditions are given the way they were modeled. For example, as depicted in **Fig. 3**, a constraint of type ‘onEnter’ can be defined that checks whether the learner has certain basic ICT skills. Constraints are specified in a given query language (in the example: SQL) and they define their own action branching for ‘onSatisfied’ and ‘onViolated’ conditions.

To enable communication between devices and to allow for communicating with overlays (as specified in the workplace model), ‘messages’ can be used: each ‘message’ specifies, which ‘target’ (device, thing, person, ...) and ‘id’ they want to communicate with. In case that the message is to a thing, the ‘overlay’ needs to be specified. Messages can also declare explicitly, which communication ‘channel’ they want to use (e.g. a real-time presence channel ‘rpc’ or an ‘xapi’ endpoint).

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <activity
3
4   id="artel14"
5   name="do-tutorial: learn about something complex"
6   language="english"
7   workplace="https://telme.kmi.open.ac.uk/tellmar/development/data/workplace.php?id=kmi"
8
9   start="welcome"
10
11 >
12
13 <action id="welcome" device="ipadba44ff" viewport="actions" predicate="find" location="SprayBooth">
14   <summons type="onEnter" removeSelf="true" timer="500">
15     <toggle viewport="actions" type="action">findOrderSheet</toggle>
16   </summons>
17   <constraints type="onEnter" satisfied="" violated="error">
18     <constraint type="boolean" condition="true">(SELECT count(skill) FROM userskills WHERE user=%u% AND skill='basicICT')>0</constraint>
19   </constraints>
20   <instruction><![CDATA[ <h1>Check the Manufacturing Order!</h1><p> ... </p> ]]></instruction>
21 </action>
22
23 <action id="error" device="ipadba44ff" viewport="actions" predicate="error">
24   <summons type="onExit" removeSelf="true">
25     <toggle viewport="actions" type="action">welcome</toggle>
26   </summons>
27   <instruction><![CDATA[ <h1>Error!</h1><p>You don't fulfill the preconditions for this learning job! Tap to try again.</p> ]]></instruction>
28 </action>
29
30 <action id="findOrderSheet" device="ipadba44ff" viewport="actions" predicate="find" location="SprayBooth">
31   <messages>
32     <message target="thing" id="orderSheet" overlay="label1">New job for Fridolin</message>
33     <message target="device" id="fwbt200" channel="rpc">Ping ;</message>
34   </messages>
35   <summons type="onEnter" removeSelf="false">
36     <toggle viewport="actions" type="action">action15</toggle>
37   </summons>
38 </action>
39
40 <action id="action15" device="fwbt200" viewport="actions" predicate="find" location="SprayBooth">
41   <messages>
42     <message channel="rpc" device="ipadba44ff">received action15 on moverio bt-200 glasses</message>
43   </messages>
44   <summons type="onTrigger" removeSelf="true">
45     <toggle viewport="objects" type="object" device="ipadba44ff">orderSheet</toggle>
46     <toggle viewport="actions" type="action">openSmartPlayerWidget</toggle>
47   </summons>
48   <instruction><![CDATA[ <h1>Go find the order sheet!</h1><p>The order sheet lists your next job...</p> ]]></instruction>
49 </action>
50
51 <action id="openSmartPlayerWidget" device="ipadba44ff" viewport="actions" predicate="watch">
52   <app type="SmartPlayer" id="16">
53     <summons type="onExit" removeSelf="true">
54       <toggle viewport="actions" type="action">interpretM0</toggle>
55       <toggle viewport="actions" type="action">checkWorkplace</toggle>
56     </summons>
57   </app>
58 </action>
59 </activity>

```

Fig. 3. Example activityML code.

Fig. 3 provides an example mock activity model. In this code example, the activity is broken down into five action steps, four of which are to be executed on a tablet PC, while one will be launched on a pair of augmented-reality (see-through) glasses. The user interaction starts with a welcome instruction to check the manufacturing order

(auto-removed after 500ms) in which a constraint validation is performed checking whether the user has the required skills (from a user profile).

If this constraint is validated, the user proceeds to finding the order sheet; otherwise an error message is displayed. To support finding the order sheet object, an action is launched on the glasses, which is toggled with sending the according id ('action15'). Once the object has been found in the viewfinder of the glasses, the next action – playing multimedia instructions in the smart player app – follows, this now again on the tablet PC.

4 Modelling workplaces

To create interoperability of applications interpreting activityML, a description of the workplace is required in a defined interchange format. We propose for this workplaceML, an XML dialect to describe the tangibles, configurables, and basic triggers of a workplace. The 'tangibles' thereby refer to 'things', 'places', and 'persons', see **Fig. 4**. The 'configurables' fall into two classes, namely 'devices' and 'apps'.

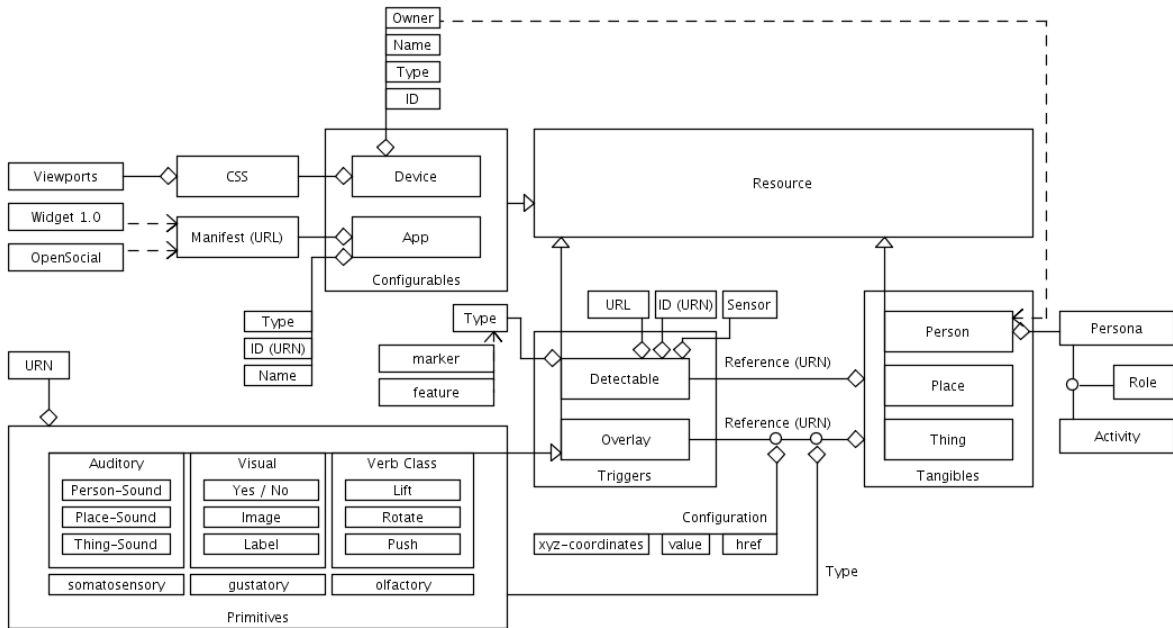


Fig. 4. Conceptual model of workplaceML.

Finally, the 'triggers' group together both 'detectables' (such as markers) and the primitives of 'overlays'. The relationship between tangibles and triggers is crucial: each tangible can specify the corresponding 'detectable' to determine how it can be detected: it can name the id of a marker, the id of a feature cloud, or even the id send

by an Internet of Things component such as an intelligent toolbox that monitors through sensors which tools are taken out or put back in. Moreover, each tangible can list the overlay primitives supported and configure them if required. For example, a ‘YesNo’ visual overlay does not require additional configuration: an app identifying the tangible will automatically overlay a green circle when it is relevant to the current action step (and a red cross, when not). This is different, for example, for an image overlay primitive: in that case, the tangible needs to specify via ‘src’ the path to the image to be displayed (and whether it shall be anchored to the detectable or to the horizon).

```

1  <?xml version="1.0" encoding="utf-8"?>
2
3  <workplace
4
5      id="kmi"
6      name="Knowledge Media Institute of The Open University"
7
8      >
9
10     <resources>
11
12         <tangibles>
13
14             <things>
15                 <thing id="thehammer1" name="The Hammer" urn="/telme/object/hammer" detectable="010">
16                     <overlay id="YesNo" enabled="true" x-offset="0" y-offset="0" z-offset="0" />
17                     <overlay id="image" x-offset="0" y-offset="0" z-offset="0" src="images/hammer.png" />
18                     <overlay id="image" anchored="marker" src="images/currentPositionLine.png" />
19                     <overlay id="image" anchored="world" rad="0degree" src="images/currentPositionLine.png" />
20                     <overlay id="rotate" />
21                     <overlay id="label" enabled="true" name="Head of the Hammer" x-offset="0" y-offset="0" z-offset="0" />
22                 </thing>
23             </things>
24
25             <places>
26                 <place id="spraybooth" name="The Spray Booth" detectable="005" type="/telme/location/spraybooth" />
27                 <place id="platform" name="The Spray Booth" detectable="006" type="/telme/location/spraybooth">
28                     <location lat="12.3121222" long="123.3422222" radius="0.000003"/>
29                 </place>
30             </places>
31
32             <persons>
33                 <person id="fridolin" name="Fridolin Wild" mbox="f.wild@open.ac.uk" detectable="002" persona="/telme/user/learner" />
34                 <person id="jake" name="Jake" detectable="003" persona="/telme/user/trainer">
35                     <device "bacfd33ba" volume="120%" />
36                 </person>
37             </persons>
38
39             <tangibles>
40
41             <configurables>
42
43                 <devices>
44                     <device id="bacfd33ba" type="ipad" name="Fridolin's iPad" owner="fridolin" />
45                     <device id="22ffdb321" type="moveriobot200" name="Fridolin's Glasses" owner="fridolin" />
46                     <device id="bac3dddf" type="ipad" name="Jake's iPad" owner="jake" />
47                 </devices>
48
49                 <apps>
50                     <app type="widget" id="smartplayer" name="TELLME smart player widget" manifest="http://demos.piksel.com/smartplayer.html" />
51                     <app type="widget" id="rating" name="TELLME live rating widget" manifest="http://telme.kmi.open.ac.uk/widgets/rating.ohp" />
52                     <app type="widget" id="precisionteaching" name="PT assessment" manifest="http://telme.kmi.open.ac.uk/widgets/pt.ohp" />
53                     <app type="app" id="flashmeeting" name="fm.mobile" call="itc://fmMobile.app" />
54                 </apps>
55
56             </configurables>
57
58             <triggers>
59
60                 <detectables>
61                     <detectable id="010" sensor="engine" type="marker" />
62                     <detectable id="015" sensor="engine" type="feature" file="featureCloud015.fcl" />
63                     <detectable id="020" sensor="snapon" type="IoT" event="returnedPliers"/>
64                 </detectables>
65
66                 <overlays>
67                     <primitive id="YesNo" type="visual" />
68                     <primitive id="image" type="visual" />
69                     <primitive id="label" type="visual" />
70
71                     <primitive id="person-sound" type="auditory" file="person-sound.wav" />
72                     <primitive id="thing-sound" type="auditory" file="person-sound.wav" />
73                     <primitive id="place-sound" type="auditory" file="person-sound.wav" />
74
75                     <primitive id="lift" type="motionverb" file="animated-arrow-away.fbx" />
76                     <primitive id="rotate" type="motionverb" file="animated-arrow-clockwise.fbx" />
77
78                     <primitive id="3dinstructible" type="three.js" file="http://threejs.org/examples/webgl_geometry_cube.html" />
79                 </overlays>
80
81             </triggers>
82
83             </resources>
84
85     </workplace>

```

Fig. 5. Example of a workplaceML file.

Certain verbs of handling and movement can be predicates of an action step (e.g. ‘lift’ or ‘rotate’) and they overlay primitives can be enabled accordingly in the configuration of the tangible.

The ‘configurables’ specify for each device the ‘owner’, a human-readable ‘name’, the ‘type’ (e.g. ‘iPad mini’ versus ‘google glass’) and its unique id. This ensures that messages can be delivered and actions can be launched and styled correctly. The ‘apps’ define the URL of the manifest file of e.g. a ‘widget 1.0’ compliant or ‘Open-Social’ compliant widget.

The code example presented in **Fig. 5** now provides the required workplace information on the tangibles (places, things, persons), configurables (apps, devices), and triggers (detectables, overlays).

From the bottom to the top, first the overlay primitives are described, i.e. a generic definition of which types of overlays exist and which modality they are overlaid in. For example, there is a person sound and there is an image overlay.

Next, the detectables are defined: this enables a pre-trained marker (‘010’), a featureless object model (‘015’), and an event from an Internet of Things sensor (‘020’). There are two types of configurables defined in this example: the devices (e.g. of type ‘ipad’ or ‘moveriobt200’) as well as the apps that can be launched, some of which through calls to the device app to be launched, others as html5 widgets.

Finally, definitions of persons, places, and things follow. Here, each tangible can further configure the overlay primitives described at the very end of the script. For example, the thing ‘thehammer1’ is bound to the marker ‘010’ and configured to support image overlays using a picture of the hammer and setting the xyz-offsets as required.

5 Related work

In Naeve et al. (2014), we have presented generic, complementary deliberations about workplace models as well as an earlier, less elaborate version of the interchange format for activities proposed (p.48ff).

ACTIVITY-DL (Lanquepin, 2013; Barot et al., 2013) builds on the former HAWAI-DL proposal of the same group and provides a hierarchical way to describe tasks for virtual reality environments. While the task description is very advanced, the language lacks capabilities for device and multi-sensor integration. ACTIVITY-DL refers to its precursors MAD (Methode Analytique de Description; Sebillotte & Scapin, 1994) and GTA (Groupware Task Analysis; Veer et al., 1996), both focusing on analysing work tasks in interaction with user interfaces. While both provide conceptual insights (e.g. on timing and on condition modelling), they do not provide bindings against an interchange format.

6 Conclusion and outlook

In this contribution, we have rooted our motivation for creating the required exchange formats for capturing and sharing (kinaesthetic) learning experiences in manu-

facturing workplaces. The transformation the industry is currently undertaking has left a skills gap, which can be closed using learning technology apt to capture, share, and guide in re-enacting innovative production activity. For this, we have described the learning process and proposed two novel interchange formats for exchanging executable descriptions of learning by doing activity and workplaces. The exchange formats are implemented in the ARgh! prototype, a first glance of which is published in the proceedings of the main conference (Wild et al., 2014).

In a world, where the time required for updating must be significantly smaller than the half-life of knowledge documented, this becomes a key enabler for experience sharing and a corner stone for success.

The specifications have already been tested against a range of storyboards of the TELL-ME project and with participants of the joint European doctoral summer school in TEL (JTEL'14). The upcoming user pilots in the TELL-ME are expected to lead to further refinements. In particular, work is undergoing at the moment to further refine the predicate vocabulary and fine-tune it to the three pilot workplaces tested (aviation, furniture production, textile inspection and production). Moreover, the xAPI integration already feeds back to the constraint validation and further updates on query language and reasoning are to be expected.

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Creating Awareness and Reflection in a Large-Scale IS Lecture – The Application of a Peer Assessment in a Flipped Classroom Scenario

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Abstract. Large-scale lectures are a typical way of teaching university students. However, these lectures often lack interaction elements and do not foster awareness and reflection in the learning process. This results in insufficient learning outcomes such as learning satisfaction and success. Therefore, a new approach to engage interaction in such large-scale lectures is the flipped classroom concept which seeks to overcome these challenges by stimulating self-regulated learning phases and improving interaction as well as awareness and reflection in the presence phases of a lecture. However, it is still unclear how to actually increase reflection and awareness through interaction in such learning scenarios. For this purpose, we propose an application of a technology-enhanced peer assessment that is carried out in large-scale information systems lectures. Preliminary evaluation results suggest the potentials of this approach. Thus, we are able to provide first theoretical and practical implications for the application of a technology-enhanced peer assessment in large-scale lectures.

Keywords: Awareness, Reflection, Peer Assessment, Large-Scale Lectures, Learning Success, Interaction, Feedback, Educational Objectives

1 Introduction

Large-scale lectures with an uneven lecturer-learner proportion (sometimes more than 100 learners per lecturer) are common in learning scenarios of universities [1]. These lectures are characterized by high anonymity and suffer from a lack of interaction in the learning process - not only among learners themselves but also among learners and lecturers [2]. Often, this results in insufficient learning outcomes and brings about unsatisfied learners [3, 4]. This development is alarming since fundamental elements of learning success include the opportunity to ask comprehension questions in order to get feedback, the possibility of sharing one's opinions concerning the learning content and of intensively reflecting on the learning content with colleagues [5, 6].

Moreover, dealing and interacting with the learning content during the learning process creates awareness and reflection regarding the learning process [7]. Additionally, interaction and collaborative learning with peers are regarded as significant predictors in terms of learning success [8] and positively influence the long-term satisfaction of learners [9, 10]. Individual learning success verification, namely in the teaching-learning process, provides individual feedback to learners [11]. This allows learners and lecturers to identify missing knowledge and misunderstandings not during the final exam, but rather early in the course of a continuous learning-progress monitoring system [11] and moreover, create awareness for the relevant specific learning content. Integrating assignments in class which create awareness and reflection to the specific learning content are very complex and addresses the high cognitive level of educational objectives [12] supposed by Bloom [13] and Anderson et al. [14], which are analyzing, evaluating and creating. However, the verification of those assignments is time- and resource-consuming hence impossible to use in a large-scale lecture. Nevertheless, introducing interaction and feedback to create awareness and reflection and moreover addressing educational objectives on a high cognitive level for individual learning success measurement in a large-scale lecture is a widespread problem.

Didactic mechanisms are needed in order to overcome the above mentioned factors characterizing traditional large-scale lectures. One promising possibility to enhance interaction and feedback and moreover to address high cognitive levels of educational objectives without massively increasing the workload of lecturers is the use of peer assessment as didactic method [15]. By using peer assessment, learners give each other feedback or credit points in terms of a performance during the learning process according to specifically defined criteria. The goal of this paper is to describe the use of peer assessment as interaction supporting component for addressing awareness and reflection in a university large-scale lecture and ultimately for increasing learning success. This paper therefore aims to answer the research question: How is a peer assessment in a large-scale lecture designed to address interaction and to improve the learning scenario? The contribution of this study is according to Gregor [16] a theory of design and action that enables on the one hand practitioners to design learning scenarios with a technology-enhanced peer assessment, and on the other hand derives theoretical implications for future research in engineering IT-enabled learning scenarios.

In order to answer the research question, the remainder of this paper is structured as follows. First, we provide a brief overview of related work that is concerned with our peer assessment. We then subsequently propose our application of the technology-enhanced peer assessment in our learning scenario. Afterwards, we present our first evaluation results and provide implications of our results in the discussion. In section 6, we highlight limitations of our study and provide on this basis guidance for future research, before the paper closes with a brief conclusion.

2 Related Work

For a few years, awareness and reflection have been, in the context of technology-enhanced learning, increasingly important and capture more attention since it has been recognized that both are key factors in helping to provide personal support in user-centric learning environments [17, 18].

The pedagogical approach aims at making learners aware of their learning behavior and at the same time intends to empower learners in creating own personal learning environments with individual learning resources while discovering their own learning patterns.

2.1 Awareness

In this context, awareness plays a central role focusing on cognitive learning activities and especially on non-observable behavior. Learners should familiarize themselves with their own and individual cognitive processes such as goal-setting, self-evaluation or help-seeking, in order to integrate them into self-regulated learning [19]. Students are confronted and made aware of key actions of their own learning behavior with the intention to make them become aware of their cognitive actions. Thereby, e-learning tools with the possibility to personalize the learning process are able to support awareness. Evaluations indicate that learners feel aware especially of their own efforts and less about the effort of their group members and the members of other groups [20].

2.2 Reflection

Reflection is an important key element in the learning activity as it allows implementing continuous improvement in order to cope with complex and permanent changing situations [21]. It is a meta-cognitive process which can be individual and also collective [22], and described as the conscious reevaluation of experience for the purpose of guiding future behavior taking into account feeling, ideas and behavior as well [23]. In the context of technology-based learning, active reflection supports the examination of own achievements as well as the work of peers and pushes for a decentralization process of problem-solving where learners are challenged and confronted with existing knowledge [21] and finally able to create knowledge [24].

Finding out about a learner's reflection can be supported by several platforms where learners communicate by sharing reports, problems and solutions concerning their work with peers [25]. Additionally, this exchange enables peers to learn from their peers and at the same time to contribute own work. In this way, learners should take more responsibility of their learning activities and efforts.

2.3 Peer Assessment

In the context of awareness and reflection in the learning process, prior research has shown that learners who interact with their lecturers and colleagues are more actively involved in the learning process [26, 27] and achieved better learning outcomes [8]. The lecturer can assess the learning progress by means of the answers and provide direct feedback. The learners have the opportunity to contribute their ideas and thoughts, thus, also initiating new thought processes [28, 29].

The use of peer assessment in class is an essential possibility to introduce interaction in a large-scale lectures and to provide formatively individual feedback in the learning progress as well as corresponding interventions by means of technical-based observation processes even in groups with a high number of learners [30, 31]. Moreover, the use of peer assessment is a favorable method to give learners extensive open-ended free text assignments hence to address awareness and reflection, even in large-scale lectures with more than 100 students, without massively increasing the lecturer's workload. In the case of peer-assessment, learners give each other feedback or credit points in terms of a performance or results during the learning process according to specifically defined criteria [32]. Peer-assessment turns learners into experts themselves and gives them a deeper understanding of the learning content [33].

The application of peer assessment in university teaching brings about, above all, the following advantages opposed to an evaluation solely done by the lecturer:

1. Logistically: Lecturers can save precious time if learners give each other feedback and evaluate each other's academic performance [33].
2. Pedagogically: The learners get a deeper understanding of the learning contents by checking and assessing their colleagues' responses. By reading works of others, one can deepen one's own knowledge and develop new ideas by evaluating other points of view [13, 33].
3. Metacognitive: Learners will develop awareness for their own strengths and weaknesses and will be able to compare and evaluate their own performances, at least to a certain extent [34]. In addition, learners train their abilities to think critically [35, 36] as well as how to evaluate and reflect [37].
4. Affectively: Learners perceive qualitative feedback from their peer group as more valuable than a lecturer's grade [33].

Therefore, the application of peer assessment does not only relieve the lecturer but turns learners into experts themselves. First observations show that evaluations done by the peer group agree with the lecturers' evaluations of the learners' academic performances [38]. Furthermore, studies show that regular feedback given by the peer group has a positive effect on the learner's learning process [39]. In their literature overview, van Zundert et al. [40] point out that there are only a few existing case studies concerning an experimental setting of peer assessment and that this circumstance prevents specific insights on how peer assessment has to be designed. Scientific literature brings up terms such as peer assessment, peer grading, peer review, and peer feedback, among others. For this paper, we use the term of peer assessment

meaning that learners of a peer group assess each other's performances as well as evaluate it according to relevant criteria without giving each other credit points.

3 Theory-motivated Design of a Peer Assessment

For the improvement of our learning scenario, we draw on a theory-motivated design approach [41, 42] for engineering learning services [43]. Therefore, we base our subsequent design decisions on the constructs linked to our phenomena of interest.

In particular, we focus on awareness and reflection as ancillary phenomena as well as on learning outcomes as the main phenomena. Awareness and reflection are closely associated with interaction in a learning scenario. Hence, we implemented a peer assessment in our lecture which supports interaction in the learning scenario and in consequence, awareness, reflection, and ultimately learning outcomes. Figure 1 depicts our theory-motivated design approach.

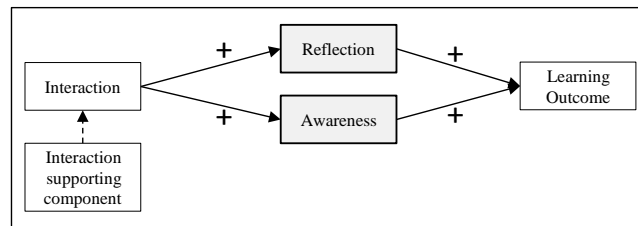


Fig. 1. Theory-motivated Design Approach

3.1 Concept of a Large-Scale Flipped Classroom

The concept of the presented peer assessment is part of a didactical concept for the flipped classroom, also known as inverted classroom [44] or inverted lecture [45]. This concept is implemented for the first time within an IS lecture at a German university. By choosing a learner-centered approach, the objectives are to increase the lecture's quality as well as to convey learner success and satisfaction. The following figure illustrates the flipped classroom concept. We therefore applied the learner-centered concept, which addresses three types of interaction throughout all phases. Referring to the work of Moore [46], the figure below differentiates between learner-content-interaction, learner-lecturer-interaction, and learner-learner-interaction.

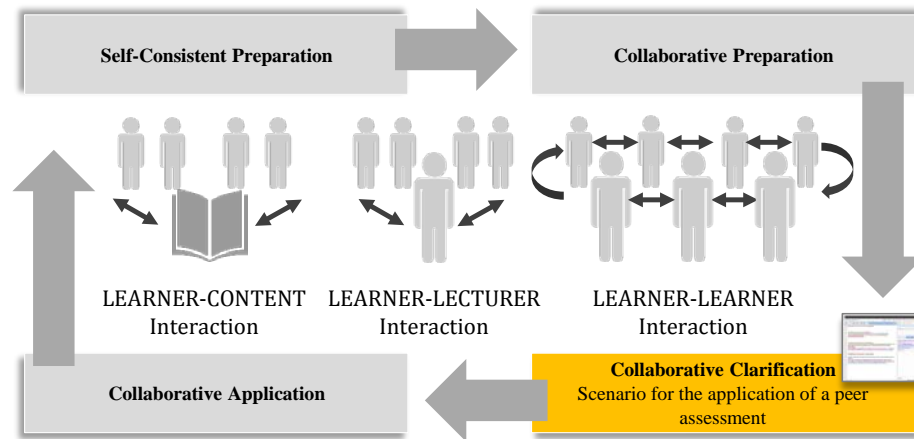


Fig. 2. Concept of a Flipped Classroom Learning Cycle Integrating Three Types of Interaction

The shown learning cycle has duration of two weeks; it will be repeated 5 times during one semester. Each cycle comprises four individual phases which are differentiated hereinafter: (1) the first phase can be substituted as self- or private study. The learners study small either video- or script-based learning units provided by the lecturer in a Learning Management System (LMS). (2) During the next phase, every learner prepares a solution for a part of an extensive open-ended free text assignment within an allocated group. Every group needs to bring their solutions on power point slides; these are used as input for the third phase, namely “collaborative clarification”. (3) This phase is held in presence. The intention of this phase is to discuss the previously submitted solutions, to consider further aspects of the findings and to emphasize its strengths. It constitutes the operational scenario for the application of a peer assessment, which is presented after a short explanation of the fourth phase. (4) The learning cycle ends with the phase of “collaborative application” which is dedicated to the tutorials. During the tutorials, all learners elaborate a common solution. In specific, they work on assignments concerning business process management and conceptual data modeling.

3.2 The Application of a Peer Assessment in a Flipped Classroom Scenario

The peer assessment imbeds itself in the third phase of the flipped classroom learning cycle. Its main goals are the collaborative clarification and consolidation of the prepared solutions submitted to the lecturer as well as gaining a deeper understanding of the learning content. Usually, an interactive learner-lecturer discussion is the method of choice. Similar to a traditional lecture, the third phase addresses the interaction type of learner-lecturer-interaction. In order to improve interaction, awareness, and reflection in the presence phases of the lecture, we developed a technology-enhanced peer assessment process addressing additional learner-learner- and learner-content-interaction. Instead of the lecturer presenting several group solutions, the learners

themselves consider strengths and weak points and revise the solutions taking into account the comments made above. By reading and assessing colleagues' group solutions the learners create awareness and reflection regarding their own group solutions. They get aware concerning their own strengths and weak points and they receive new ideas concerning the learning content. Hence, the peer assessment took place in a synchronous and written form via an online chat using a web based application. After finishing the peer assessment, the lecturer adopts the role of a moderator and supports the learners in the organization of a feedback loop. Figure 3 illustrates the structure of the presented peer assessment.

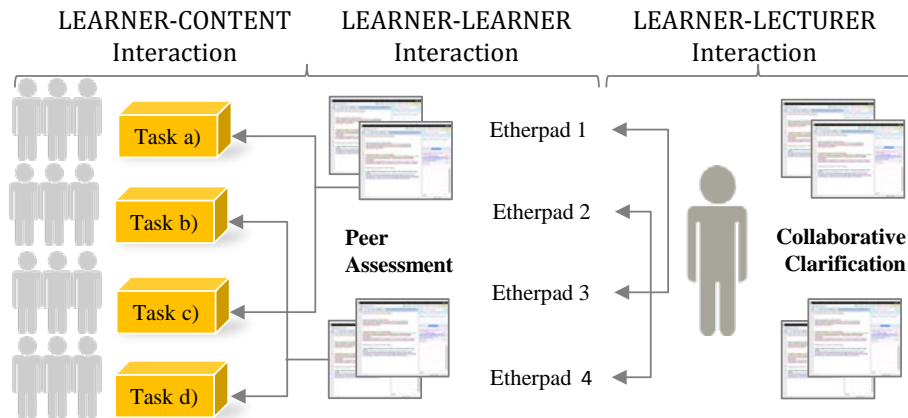


Fig. 3. The Process of a Peer Assessment

Aware of the restrictions of our lecture room, we applied a web based application, to enable the learner participating to the process of a peer assessment. We therefore used an etherpad as a collaborative online notepad. Etherpad documents are accessible via web browser and support multiuser usage without having to create multiple user accounts [47]. Being real time, capable etherpads enable people to collaborate on ideas, concepts and brainstorming. The selected etherpad has a chat bar on the right sidebar as well as a basic formatting functionality, and allows anonymous or public access. To help the learners during the peer assessment process, all learners are provided with an etherpad compromising the intended assessment structure. Specifying the date and the learning unit, the created text gets manually stored in text files and uploaded to the LMS. Figure 4 shows one out of four generated etherpad documents during our lecture.

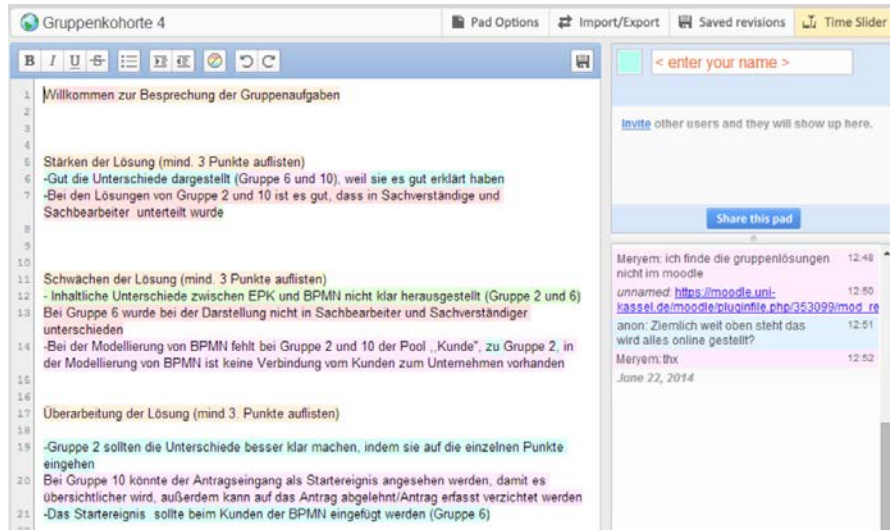


Fig. 4. Technology-enhanced Peer Assessment

4 Evaluation

In order to evaluate our technology-enhanced peer assessment, we surveyed the participants of our lecture. We therefore provided a paper-based pre- and post-test during the lecture. As stated before, we embedded our peer assessment in a flipped classroom IS lecture. Before the presence phase in the lecture hall and the peer assessment, four groups of students worked collaboratively in an online forum on four different assignments. Each group prepared group individual presentations to a different assignment and posted the assignments to the online forum. Before conducting the lecture, we administered the prepared group assignments to the other groups. In the actual lecture, the other groups assessed the elaborated assignments of the other groups. Afterwards, the lecturer moderated a discussion of the collaborative peer assessment. To evaluate our procedure, a pre-test was administered before conducting the peer assessment. Afterwards, the peer assessment was conducted as described above and at the end of the lecture, the post-test was administered. In the survey, 35 learners who participated in the peer assessment process answered voluntarily both parts of the survey, which contained questions regarding the experience with the peer assessment. All items of the survey were adopted from literature and adapted, if necessary, to our research context. The items for measuring the perception of the peer assessment were adopted from Pearce et al. [48] and perceived learning outcomes were adapted from Eom et al. [49].

The pre-test asked questions about the learners' experiences and expectations regarding the peer assessment. The results show that only 26 percent of our sample had previously participated in some sort of peer assessment, i.e. paper-based or technology-enhanced peer assessment. Considering the phases of the peer assessment, the

majority (60 percent) of the learners expected that both writing and receiving feedback would contribute the most to their learning outcomes. 25.7 percent expected that receiving feedback and 5.7 percent expected writing feedback would contribute the most to their learning outcomes (including 8.6 percent nonresponse). Figure 5 provides details about the further results of the pre-test. Both items were measured on a five point Likert response format (1 = strongly agree; 5 = strongly disagree). Overall, the results show that the learners expected up front that the peer assessment would be useful as a scaffold in the learning process (PA1). Also, the learners expected that their peers were qualified enough to provide valuable feedback (PA2).

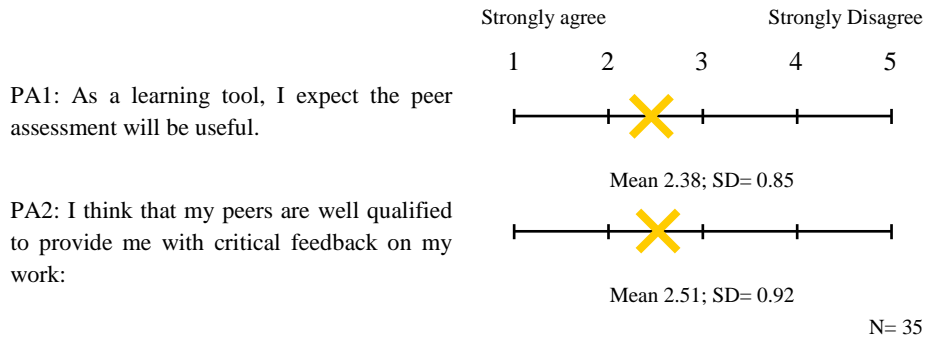


Fig. 5. Results of the Pre-Test

After conducting the peer assessment, we administered the post-test. First, we measured which part of the peer assessment influenced learning the most. The results show that the learners' expectations were confirmed, since 45.9 percent reported that learning results most from both writing and receiving feedback. Figure 6 shows further results of the post-test. All items were rated on a five point Likert response format (1 = strongly agree; 5 = strongly disagree) and provide the mean value and standard deviation (SD) of the responses. In addition, a one sample t-test was conducted in order to evaluate whether the mean values for all of the questions are lower than the neutral value. In consequence, the usefulness of the peer assessment is shown implying the rejection of the null hypothesis $H_0: \mu \geq 3$. The results show that several items were rated under the neutral value of 3, indicating, in general, a good fit of the peer assessment. Additionally, the t-test provides evidence that H_0 is not supported by several items (at least $p < 0.05$), and can thus be rejected in these cases. The indicator PA3 was rated as good, on average (2.74) showing the overall usefulness of our technology-enhanced peer assessment. PA4 however did not provide significant results. Therefore, we are not able to provide evidence that the peers involved in the peer assessment were actually suitable to conduct the assessment. In contrast, with a highly significant result, PA5 shows that our participants were able to improve their solutions after the assessment. Considering the learning outcomes in terms of learning success, LO1 was found to be significant and LO2 was found to be insignificant. These results are not really contradicting, since they demonstrate that our participants felt that the peer assessment itself did not actually affect the learning outcomes and

that they have learned as much without participating in the assessment process. Further analysis of item LO3 showed that on average (2.71) the learners noticed an improvement of the learning experience and quality.

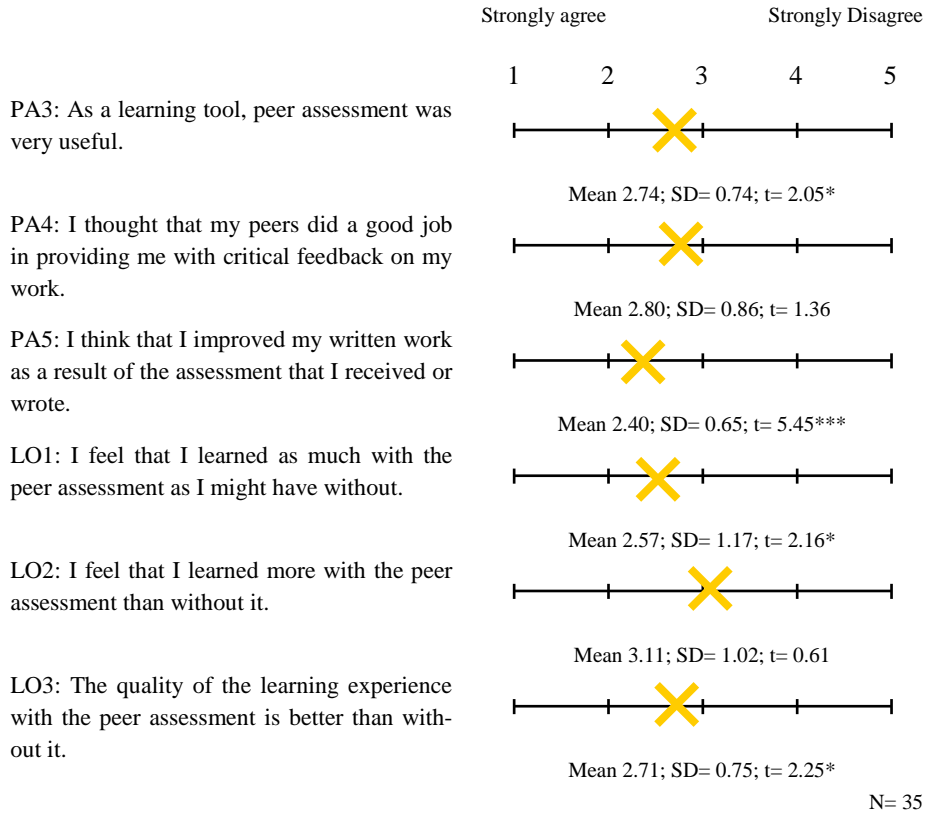


Fig. 6. Results of the Post-Test

5 Discussion

The present study was designed to determine whether an application of a technology-enhanced peer assessment is a suitable instrument to engage awareness and reflection of the learners by improving interaction in our lecture. Our results indicate that the expectations of the learners concerning the usefulness of the peer assessment were confirmed. This is in line with previous research results, which also indicated the usefulness of peer assessments in higher education scenarios [50]. However, we confirmed the suitability of the peer assessment for a new learning scenario driven by a rich interaction in large-scale lectures. Surprisingly, our results show that the perception of the learners did not reveal any significance for the suitability of their peers for the assessment process. The present findings seem to be consistent with other research

which found that trust in the peer as an assessor is not a significant predictor for learning outcomes [51].

This is also shown by the qualitative insights we gained during our evaluation. One learner states in the evaluation: “The idea is good, but the other students need to collaborate better.” This opinion also relates to the results of our post-test, which revealed that most of the learners were not satisfied with their peers. Therefore, we acknowledge these issues by suggesting the implementation of further components that actually enhance a rich learner-learner-interaction to provide a useful process of awareness and reflection in the learning process. This is also highlighted by the following statement of another student: “The procedure is very good and modern, but it depends very much on the fellow students”. Therefore, we also want to highlight the importance of the faithful appropriation of such a learning method. If the learning methods and structures, such as our technology-enhanced peer assessment, are ironically appropriated, learning outcomes may suffer [52–54]. For instance, we noticed that students ironically appropriated the chat function and did not use it for a purposeful discussion. As an implication, we would suggest to guide the learning process and provide best-practices how to use the tool faithfully. However, our results also show that the received peer assessment improved the assignments of the learners. We therefore highlight the importance of the feedback provided by the peers in order to improve learning outcomes.

Considering the learning outcomes, we found evidence that the peer assessment has no significant impact on the subjective learning outcomes in our study. However, subjective perceptions have to be judged carefully, especially in the context of learning success [55, 56]. Therefore, we cannot make any definite prediction on how peer assessments actually improve learning outcomes in a flipped classroom scenario. Interestingly, further analysis of the learning outcomes showed that the learners noticed an improvement of the learning experience and quality. This also relates to our results that the peer assessment as a meta-cognitive scaffold is a useful method to improve the learning process and in consequence increase learning outcomes [54, 57].

To sum up, we sought to address interactivity in the learning process as means to improve awareness, reflection, and learning outcomes in our learning scenario. Considering our evaluation results, we can state that the peer assessment is a useful method for structuring presence phases in a flipped classroom scenario. Hence, we highlight as a practical implication the importance of the learning process and the reflection of the learning outcomes by interacting with it. This procedure also creates awareness of the learning progress, enabling learners to actually improve their self-regulated learning activities which are especially important in flipped classroom scenarios.

6 Limitations and Future Research

This study of a peer assessment in a flipped classroom is still on-going and therefore comes with limitations regarding the evaluation and application. Concerning the evaluation, we consider the poor response rate in our evaluation. Typically, our lecture is

attended by 150-200 students. Since we did not provide any compensation for participating in our survey, the external value might be affected, because maybe only learners well-disposed to such innovative learning concepts participated. In consequence, we consider this limitation and plan to evaluate the peer assessment in an additional and compulsory longitudinal online survey to account for the evolving nature of interaction with e-learning components in the learning process. In addition, we plan to evaluate the actual effects of the peer assessment by conducting an experiment with a peer assessment treatment group and a control group.

Furthermore future work should investigate peer assessment as instrument for individual learning success verification during the learning process. Following Bloom's [13] suggestion, transfer and verification of learning content should be adjusting to various cognitive levels of educational objectives. In large-scale lectures the verification of high cognitive levels of educational objectives is very time- and resource-consuming and hence impractical in use. Peer assessment should be investigated as time- and resource-saving manner to measure learning success during the learning process.

The other part of our limitations deals with the on-going application of our peer assessment. We applied the peer assessment in our lecture for the first time. Hence, we are still adjusting and modifying the process for the deployment of the peer assessment. In consequence, our evaluation could be biased by effects that are induced through the first time application, e.g., glitches that are mainly concerned with usability issues. However, we seek to overcome these limitations with a broad application during the next terms and further insights by this application. This would also include the application within other learning scenarios, especially those that are influenced by cultural differences [58, 59].

7 Conclusion

This paper has examined the application of a peer assessment in a large-scale IS lecture arranged in a flipped classroom setting. We therefore provided first evidence of the utility of peer assessments as suitable instruments to increase awareness and reflection as well as to strengthen learning outcomes in an IS lecture. The results of this investigation show that the peer assessment itself does not affect the learning outcomes, but it does have a positive impact on learning experience and quality. Although the current study is based on a small sample of participants, the findings suggest that the application of a peer assessment might be a useful instrument to effect awareness and reflection. Considerably more work will need to be done to determine the effects of a technology-enhanced peer assessment on awareness and reflection as well as on learning outcomes.

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Application overlapping user profiles to foster reflective learning at work

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Abstract. Reflective learning is an important activity of knowledge-workers in order to improve future working-behaviours. The insights gained by reflective learning are based on re-experiencing and re-evaluating past working situations. One time- and cost-effective way to support reflective learning is the employment of applications that collect data about working processes, store the data in user profiles, and visualise it in order to provide timely feedback to the employees. However, a single application can only capture part of the data that might be relevant for reflection and the parallel use of several applications leads to high demands on the user regarding the interpretation of relationships between several single visualizations. A combined visualisation of data captured by different apps should enhance the support for reflection about the working behaviour and experiences. This paper introduces an overlapping user profile application, which combines and aggregates data captured by various applications. The goal of this overlapping application is to provide higher-level reflection possibilities by combining visualisations of different application data in order to better induce and support reflective learning at work. A first proof-of-concept of such an approach indicates that a combined user profile application and especially its visualisations can be beneficial with regard to reflective learning and can enhance the awareness about the multiple aspects of a user's work life.

Keywords: Work-place learning, reflective learning, awareness, user profiles, reflective data analytics

1 Introduction

Today's work environments are constantly becoming more complex, globally integrated, and knowledge-centric. This simultaneously leads to a stronger need of employees who are motivated and capable to reflect upon their activities and as a consequence adjust their working practices to new demands. Especially for knowledge-workers, reflective learning is an important activity to re-experience past situations during work and to learn from them in order to improve their future working-behaviour [2]. One possibility to motivate knowledge workers to become reflective practitioners is to support them with corresponding tools

or applications, which could be easily integrated into their daily work-life [14]. These applications have the task to gather data from work processes and to provide guidance for reflection in form of raising awareness and offering triggers with regard to unusual or extraordinary work related experiences or situations. In contrast to formal learning settings, reflective learning at the workplace deals with informal and self-regulated learning, where challenges like no additional working effort, easy integration in daily working routines as well as a clear benefit for knowledge workers have to be considered right from the beginning.

In order to support reflective learning at work, within the EU-funded project MIRROR (<http://www.mirror-project.eu>) several applications have been developed, which aim at motivating and activating users to reflect upon their individual working experiences. After the reflection process itself, knowledge workers should have gained some benefits or insights for themselves and as consequence derive and apply behavioural changes for future working situations. These changes should permanently improve and facilitate the handling of upcoming similar situations or experiences.

The applications developed within the MIRROR project have been applied within a wide range of working environments (e.g. care homes, hospitals, IT companies, and emergency situations) and support various sets of professionals (e.g. knowledge-workers, nurses, physicians and carers as well as emergency workers). Each of the developed applications collects and gathers different kinds of data and stores them in their corresponding user profiles. This data encompasses on the one hand information about the user. On the other hand it consists of information on users' work processes, which is captured automatically or inserted manually during the user's work. Examples are application switches, application usage and documents used while working on a PC as well as manually inserted data such as the current mood status of the user, individual notes, feedback on different working situations, ratings, scores of serious games or quiz results. The collected data is stored within the applications themselves and for some applications additionally in the so-called MIRROR Spaces Framework [20], an underlying data storage system for exchanging data between applications. In the spaces framework, the user's data is stored in the user profile and is accessible only by its owner. Each of these single applications visualises the data for the user in a sophisticated way with the goal to trigger reflective learning. However, user studies conducted in different environmental settings (e.g. [9], [16]) showed that single applications can only capture part of the data that might be relevant for reflective learning. Participants of these studies asked on the one hand for a better guidance to interpret the data in order to initiate reflection. On the other hand they wanted to see a clearer benefit for themselves, which would serve as motivational trigger to use the application and to reflect about the captured data. Thus, similar to research outcomes from the field of learning analytics, we found that a combination of data is often more adequate for successfully supporting users. Whereas learning analytics addresses self-reflective learning mostly as important aspect of self-regulated learning in formal learning environments, we focus on work-related reflective learning in informal learning environments.

With this paper we want to present a first approach on how to meaningfully combine and visualize data captured by different applications. The goal is to provide a greater variety of reflective learning opportunities in order to facilitate deeper insights on one's working experiences. We are aware that this approach raises privacy and security issues which need to be carefully considered when employing the app in a real working environment. However, for this first approach privacy and security were only of secondary interest, but will of course be treated in upcoming research settings.

Therefore, we developed the so-called "MIRROR Integrated User Profile" application (MUP App) which has the task to integrate, summarise, analyse, and visualise data captured by several different applications in order to induce and support reflective learning at work. For a first proof-of-concept, we used two different applications in parallel, namely KnowSelf and the MoodMap App. KnowSelf automatically captures work activities on a PC, whereas the MoodMap App allows knowledge workers to easily state their moods during a working day. We collected, aggregated, and visualised data from a small sample of knowledge workers to get a first impression of users' interest and motivation and the app's usefulness. From this we derived the following three research questions:

- RQ1: Are participants interested and willing to use more than one application in parallel with regard to reflective learning?
- RQ2: Does the MUP App as overlapping application facilitate reflection about users' working experiences and contribute to raising awareness of multiple aspects of their work life?
- RQ3: Do participants perceive any individual insights or benefits for themselves?

2 Related Work

2.1 User Profiles

Since the terms user profile and user model are not always used in exactly the same way, it is essential to clarify our understanding and usage of the term user profile, which we base on existing theories regarding user models and on our understanding in MIRROR described by [15]. **User models** in general are models that computer systems have about their users. The data in such user models is automatically captured by the system and is mainly used in information retrieval and intelligent tutoring systems or user-adaptive learning systems (see e.g., [10, 1]). User models, which are utilised in learning environment systems for modeling the learner and the corresponding learning activities, are called **learner models**. These types of user models are created by the systems automatically and are not directly accessible by the users via user interfaces. Furthermore they are used to adapt teaching strategies or to inform the learner about the learning progress as basis for reflective learning. Additionally [3] suggested that learner models should keep data like knowledge, interests, goals, background, and individual traits, thus abstract concepts relevant for learning. In order to

apply a user model or learner model as basis for reflection on one's own learning activities, achievements, or progress towards the individual learning goals, it is necessary to make the models accessible and manageable for the user, which was explicitly suggested by [12] and mentioned in [4, 5, 13].

In MIRROR we prefer the term **user profile** (UP). Although the MIRROR user profile (MUP) is based on theory and research of user models, the term user profile better reflects its mission in MIRROR. First, the purpose of the MUP is to guide and support reflection by mirroring user data in the form of activities, experiences or artefacts of work, notes and insights, moods, work practices, and other concrete data sources back to the user. Secondly, we intended these user profiles to be created and maintained by a mixture of automated methods and manual management, where the process of editing or updating the data may also explicitly trigger reflection.

2.2 Learning Analytics

Although learning analytics is not in focus of our work, several approaches, methodologies and technologies of this research area are closely linked to reflective learning. Learning analytics deals with methods for analysing and detecting patterns within data collected from educational settings or learning environments about the learner, and leverage those methods to support adaptation, personalisation, recommendation, and also reflection. Siemens [21] defined learning analytics as *'the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning'*. The focus of learning analytics is on the support of the learner in formal learning setting, while in our work the focus is to support the knowledge worker in an informal learning setting. Nevertheless, the parallel to our work is evident. Also approaches like learning dashboards for example described in [8, 19] present an overview of the learner's own learning activities and learning progress, and in relation to colleagues at one glance. Such combined visualisations support self-monitoring for learners and awareness for teachers as well as empowers the learners to reflect on their own activity, and that of their peers. Explicit traces (e.g. the learner's entries in a chat or a discussion forum) and implicit traces (e.g. the learner entering a course or clicking on a document) stored in the corresponding learner profiles serve here as basis for the aggregation and visualisation of the gathered data.

The main focus of learning analytics is to support the learner while learning in an educational setting or learning environment. Although learning analytics includes also reflective learning approaches (e.g. [18, 17]), our work can be clearly distinguished from these approaches by focusing on knowledge workers in real working environments and and to support reflection on working experiences or working artifacts in order to learn from them to improve future work.

2.3 Reflective Learning

Individual reflection takes normally place in every day's life and obviously also during work or work-related situations. Reflection may be triggered by different reasons for example by conflicts or problems, by unexpected experiences or by a person acting in a complete different way in comparison with the individual (external trigger). But also if an individual feels uncomfortable, for something bothers her or an inner voice is nagging, without being able to make this feeling external (internal trigger). As reaction, a reflection process may be triggered with or without the awareness of the person. This reflection should lead to an individual insight or outcome which may be used to guide or adapt future behaviour. Within MIRROR we follow the definition of [2], who define reflective learning as *'those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations'*.

Bringing this together, reflection is both a crucial part of learning and a response to past work experiences. These experiences as well as the behaviours of the individual engaged serve as starting point for the reflective process. The desired outcomes of reflection may lead to personal synthesis, integration of knowledge (internalisation), validation of personal knowledge, a new affective state or the decision to take on actions for future events. To achieve these results the characteristics of the individual (learner) have to be taken into account as well as the intention of the individual self. Individual reflection may occur spontaneous and unconsciously and in any possible situation especially then when it is not expected [6]. Of course it can also be consciously triggered by peers supervisors or by meeting created specifically for that purpose [7]. Within MIRROR we focus to initiate reflective practices with the support of technologies, which might automatically detect unusual working patterns and working behaviours and by making the worker aware of them in form of reflection triggers or explicit reflection guidance e.g. by means of prompts.

3 Examples of MIRROR Applications

In the scope of the MIRROR project a series of applications supporting individual reflection have been developed and evaluated in different settings [16, 9]. Some of the user studies showed that gathering and visualising data captured by single applications is not always enough to initiate reflective learning. To illustrate how the MIRROR applications support reflective learning, we want to shortly introduce two applications, namely KnowSelf and the MoodMap App. The same two applications will later be used as example for a possible combined usage and integration via the MUP App.

KnowSelf automatically captures work activities (used applications and resources together with the exact time of use) on a PC, provides simplistic project and task recording and presents an overview as well as different visualisations of the captured data [16]. Providing these visualisations regarding time use at work should lead to reflection on personal time management and potentially motivate to consider improvements in this respect. The user profile of KnowSelf

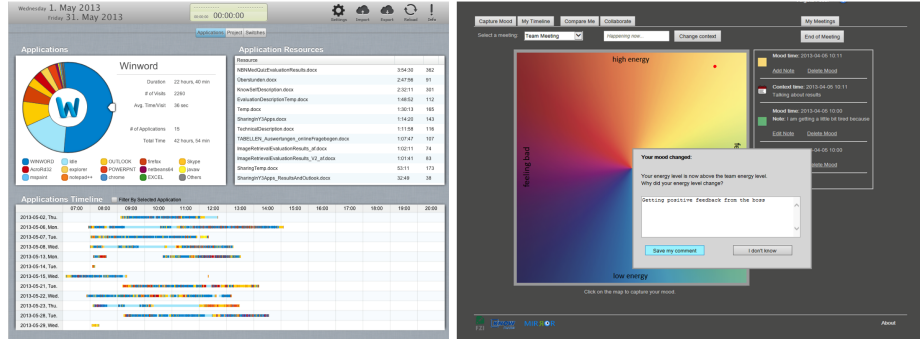


Fig. 1. KnowSelf (left) and MoodMap App (right)

is not a conventional user profile, because it consists only of user activities, but not of information about the users themselves. The application stores all work activities captured on the user's computer, including window focus and title, if applicable the system location (path) of the resource, focus switches, and idle time. Additionally the user can manually record time spent on projects or tasks and save observations. The collected information is displayed on a timeline and as statistics in the form of pie charts.

The **MoodMap App** is a web-based application, which allows knowledge workers to track their mood during a working day or virtual meeting and recapitulate their work experiences afterwards. The MoodMap App provides an easy-to-understand user interface to state individual mood points by simply clicking on a bi-dimensional coloured map. Each mood is composed of two dimensions, namely valence (negative to positive feelings) and arousal (low to high energy) based on the model proposed by [11]. Additionally, it provides several visualisations on an individual as well as collaborative level, to make users reflect on the mood development over time or to provide easy comparison possibilities of one's own mood with the mood of others for example colleagues or team members of the same team. The application related user profile stores information about the user, sharing settings for security and privacy issues as well as individual email settings. Furthermore, individual moods and inherent notes, corresponding meetings, context information of a day or meeting, as well as personal diary entries are stored in the internal user profile of the application.

4 The MIRROR Integrated User Profile (MUP)

Insights from evaluations conducted separately for KnowSelf and the MoodMap App led to the conclusion that single applications capture only part of the data that might be relevant for reflection [9, 16]. Although the developed applications proved to have high potential to trigger reflection at work, we wanted to go one step further. As a first step, we made triggers from different sources easily

accessible to the users, in order to further facilitate the reflective learning experience and help users to get more insights at one glance. Thereupon we developed the MIRROR User Profile (MUP) concept, which focuses on the combination of the captured data and corresponding sophisticated visualisations. An early prototype of the MIRROR User Profile Application (MUP App) was realised and tested with a small sample of knowledge workers.

4.1 Prerequisites for the MIRROR User Profile

In order to efficiently implement a common MIRROR user profile, it is of crucial relevance to use data captured and gathered by several MIRROR applications and not only by a single one. To achieve this, we employed the MIRROR Spaces Framework, an underlying data storage system developed within the MIRROR project to store and exchange data of the applications. For the development of a common user profile based on the MIRROR spaces the following prerequisites have to be considered: assumptions regarding (i) data, (ii) reusability, (iii) sharing, (iv) privacy and security, and (v) accessibility by the user interfaces.

Data stored in the MUP can be divided into three different types, namely personal data about the user, private data, and shared data. Personal data about the user consists of general information about the user (e.g. name or email address) and login information. For the data implicitly captured by the MIRROR applications (e.g. work history in KnowSelf) as well as data explicitly inserted by the user (e.g. mood in the MoodMap) it is essential that the user has full control over her data by deciding for each type of captured data, whether it is private or can be shared.

Reusability is one of the major potential benefits of the MUP. By storing the data according to a predefined data format, applications are able to reuse not only their data but the data captured by other applications and other users as well. Account information can be stored once in the user profile and then be used by all MIRROR applications.

Sharing data is of major relevance for reflection in order to provide possibilities for comparing one's own data with that of colleagues or a whole team. To account for different levels of sharing, settings (e.g. anonymised, sharing within the same team or department) should be very fine-grained.

As mentioned above **privacy and security** are a major concern when storing data in the MIRROR Spaces Framework. It has to be ensured that the privacy settings defined by the users via different applications are always met by all applications, aggregations, and visualisations.

Sharing, privacy and security settings along with other data gathered either explicitly or implicitly by applications, should be **accessible and modifiable** by user-friendly interfaces and visualisations provided by each MIRROR application. This has the advantage, that the user has full control about the data and has the potential to decide on a very fine-grained level, which data she wants to share with whom and which data should be kept private only.

4.2 The MIRROR Integrated User Profile Application

The MIRROR Integrate User Profile Application (MUP App) serves as a bridge between the MIRROR Spaces Framework and various MIRROR applications. It provides services for data administration as well as for directly supporting reflective learning. The latter is achieved by making users aware of unusual or significant behavioural patterns. The MUP App's service can be used by other applications to show and promote reflective learning by presenting combined data aggregated by different applications or from different users.

The tasks of MUP App are two-fold, providing (a) access to the data stored in the corresponding user profiles per user within the MIRROR Spaces Framework and (b) a data analysis service, which aggregates data from different applications (on an individual level) and/or from different users (on a collaborative or organisational level). The aggregated data can be used to raise awareness on relationships between data captured from different applications, make comparisons along a timeline or among different users, and finally detect patterns that are relevant for individual or collaborative reflection. Reasons for reflection can encompass the need for problem solving, decision-making, emotion regulation, or detection of significant deviations between the individual user and a team.

In this first phase of the development we pursue a more general approach directed towards basic types of data that are comparable across different applications. We mostly focus on statistical analysis to extract information on for example the number of different applications used by an individual, on providing a chronological overview of the applications used, on presenting the number of entries in various diaries, and on general information (e.g. when, how often or which data) was captured by each application. The data is presented on different types of charts, which can be selected by the user in order to ensure that the chart fits to the available data. In addition, the user may visualise her data in direct comparison with the data to other users (e.g. her team-members).

For the second phase, we will be concentrating on the different types of data captured by various applications, in order to provide analysis on the combined data. For instance, combining the usage of the MoodMap App with data captured by KnowSelf, might show a relationship between moods and specific working tasks. This would lead to new insights that may be the basis for initiating reflective learning. As an example, the left of Fig. 2 shows the hourly application usage history of a single user for both KnowSelf and the MoodMap App. The picture on the right of Fig. 2 visualises combined application specific data, namely the number of hourly switches between tasks or resources captured by KnowSelf and the corresponding mood of a user, depicted as separate lines for arousal (mood.energy) and valence (mood.feel) by the MoodMap App. For this visualization, mood values from the MoodMap App depicted in Fig. 1 are expressed as numbers between 0 and 100.

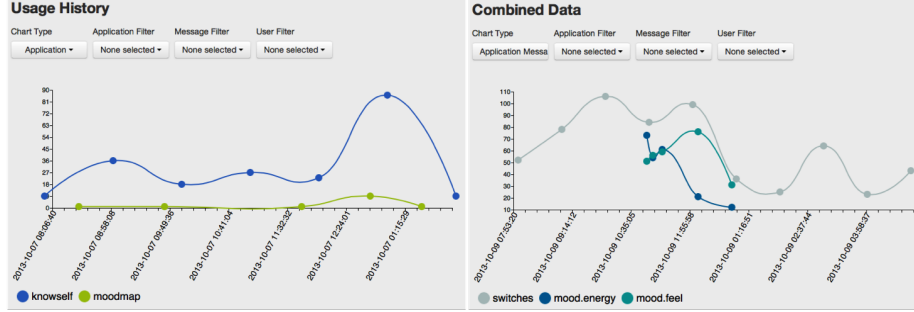


Fig. 2. MUP application with MoodMap and KnowSelf data for a single user

5 Proof of concept

In order to investigate the potential of a common MIRROR user profile as support for reflective learning, we conducted a small combined user study employing the KnowSelf and the MoodMap App in parallel. Although we used only two application for this first evaluation, the MUP App is able to handle all applications that store their data in the common user profile. Based on what we have learned from the separate evaluations, we see this study as first proof-of-concept for the MUP App. The goal was to find out whether a combined analysis of data from both user profiles will i) be accepted by the users, ii) enhance the boost of reflective learning, and iii) provide clearer insights or benefits for the single user.

5.1 Setting

The participating team consisted of 6 knowledge workers (3 women, 3 men), on average aged between 30 and 40, all of them mostly doing computer work. They used the KnowSelf and the MoodMap App in parallel for two weeks during work. Each day, either in the morning or in the evening they were asked to re-evaluate and reflect about their captured data and write down their insights and thoughts directly within one of the two applications. User activities automatically logged by KnowSelf could only be analysed for 5 persons due to technical reasons on one of the PC's. At the end of the trial the participants were asked to fill in a questionnaire and to take part in a semi-structured interview.

The questionnaire covered information regarding features and functionalities of the applications, usage, and reflective learning. During the interview, combined statistics (see Fig. 2) of the captured data were presented and discussed in order to find out the insights and benefits gained for the individual user.

5.2 Results & Discussion

The analysis of the log data of both applications is depicted in Fig. 3. Because of the small sample size only descriptive statistics are presented. As measure of central tendency the median is used for the same reasons. Each data point represents the average mood values (in terms of valence and arousal) of one participant in relation to the application usage and working activities (switching frequency and used resources). Whereas there is no trend to be derived from this small sample for the active use of KnowSelf, the number of moods entered per day seems to increase with higher valence and higher arousal values indicated by the participants (i.e. with a more positive mood). Switching frequency was measured in seconds between switching from one resource to another. Fig. 3 (bottom) shows that higher reported valence seems to be connected to longer times between switches (that is a lower switching frequency) and fewer resources used. Interestingly, the arousal level increases with the number of used resources.

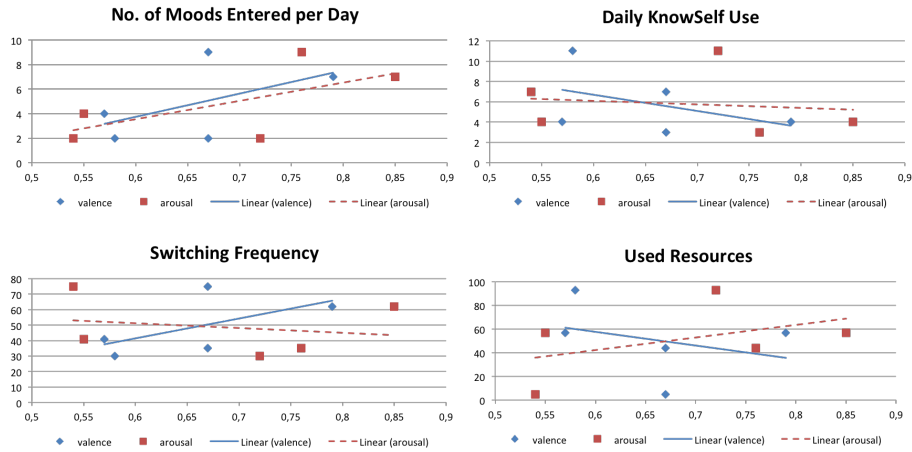


Fig. 3. Relationship between mood (as valence and arousal), application usage and working activities

Analysing the data collected via questionnaires and interviews, we can give first answers to the research questions:

RQ1: Are participants interested and willing to use more than one application in parallel with regard to reflective learning? Ratings from 6 participants answering the questionnaire (using 5pt. agreement scales) indicate that there is an interest in getting support for time-management (Md (median) = 4) as well as in capturing one's working activities, own mood, and the team mood (all $Md=3.5$). Participants found the applications easy to use, liked their visualisations, rated the presentation of information as comprehensible (all $Md=4$),

generally liked using the applications and would recommend them to colleagues (for both items $Md=4$ for KnowSelf and $Md=3.5$ for MMA, respectively).

RQ2: Does the MUP App as overlapping application facilitate reflection about users' working experiences and contribute to raising awareness of multiple aspects of their work life? The interview results revealed that the combination of data has high potential to trigger reflective learning although we have ambiguous statements in which way. One participant reflected mainly on the number of used applications and its relation to how the level of arousal developed over the day. Another participant mentioned that combined data helped her to detect a working pattern, which occurred especially in the morning. After reading emails the application switches and the arousal level increases, thus she knows that she started to work. Similarly, one of the participants observed that her arousal level is very low in the morning and increases during the day. This was a trigger to compare her arousal level to the average level of her colleagues and reflect upon eventual differences between them. An important feature mentioned by more than one participant was the overlapping visualisation of captured data on the timeline chart. Here the data was understood at one glance, which can facilitate reflective learning and enhance awareness of the multi aspects of their work life. Despite of the different approaches to reflect, for all participants the combination of data captured by both applications was important to understand the relationship between their working activities and moods.

RQ3: Do participants perceive any individual insights or benefits for themselves? Besides the findings already described in relation to RQ2, participants reported some additional insights they gained by reflecting on the captured data provided by the MUP. One participant stated that her arousal level fluctuates during the day. By becoming aware of the falling arousal level she decided to take smaller breaks to better recover during the day. Further insights concerned participants' self-estimations of how they spend their working day. Whereas one participant stated that the captured data confirmed how she estimated the relationship between working activities and mood development, another participant was rather surprised in the first place. Although she was six to seven hours in the office she spent only four hours in front of her computer. Only after comparing this awareness with her dates in her calendar, she could reproduce her day and explain why this happened.

General discussion. In general, this first proof-of concept of the MIRROR Integrated User Profile indicates that such overlapping visualisations can facilitate individual reflective learning and raise overall awareness of users' work life. All six participants used the combined data to reflect on how their working activities are related to mood changes and could gain some individual insights. Nevertheless there are still some points which need further discussion. While KnowSelf captures automatically the resources and applications used on the PC, the moods need to be inserted manually. Having to repeatedly insert a mood in a web based application can distract from the normal working process. One recommendation to alleviate this distraction was to add five different smileys in the system tray to facilitate the mood capturing. Another point for consideration is the

optimal time for reflection. All of the participants perceived the combination of the data captured by the MoodMap App and KnowSelf as useful, because they could check at all times what they were doing during work and how they felt. However, one participant stated that it was not very useful to reflect on how she felt three days ago, but that it was more interesting to become aware of her mood in relation to her work directly while working. For other participants especially the knowledge of how they felt for example three days ago was very important. Especially when the mood could be directly related to the mood note, used applications or used resources. A rather interesting statement from one of the participants was that her working tasks did not influence her mood at all. With respect to the visualisations, the interviews showed that different types of aggregating the data would be useful, so that users could indicate their individual preferences, e.g. to visualise the data along a timeline, to aggregate on an hourly basis, or to offer a summarising view in form a pie chart.

In summary the MUP App provides new visualisations based on data captured by different applications, and therefore offers a multitude of new possibilities for individual interpretations. In our proof of concept, we only combined data of two applications, but also within this small setting we received different approaches on how the participants interpreted the captured data for themselves and what they learned from it. We also mentioned some shortcomings which must be taken into consideration when proceeding with the development of the MUP App. Nevertheless, our findings encourage the assumption that combining data of more than two applications, leads to more meaningful possibilities to interpret the data and to gain more diverse insights for oneself.

6 Conclusions and Outlook

In this paper we presented the new MIRROR integrated User Profile Application, which aims at supporting reflective learning at work. Based on the results from previous user studies, which evaluated single applications, we derived essential requirements for the development of the MUP App and implemented a first prototype. Results from a first small evaluation regarding the parallel usage of two applications indicate that combining data captured by different applications, analysing and visualising them together can further facilitate reflective learning. Furthermore, it can also enhance awareness of the work life by leading the users to get more diverse insights about themselves. Of course, after this first proof-of-concept, user-studies with larger samples and more applications need to follow. Thus, our future work will focus on the integration of further applications developed within the MIRROR project into the MUP App. The goal is to provide different variants of visualising combined data and more sophisticated ways to provide guidance for reflective learning. For example, Fig. 4 combines KnowSelf data with corresponding geo location data captured by another MIRROR App. Thus it makes you aware of your working activities in relation to your working places (e.g. customer visits or travel activities) and can provide more triggers for reflective learning.

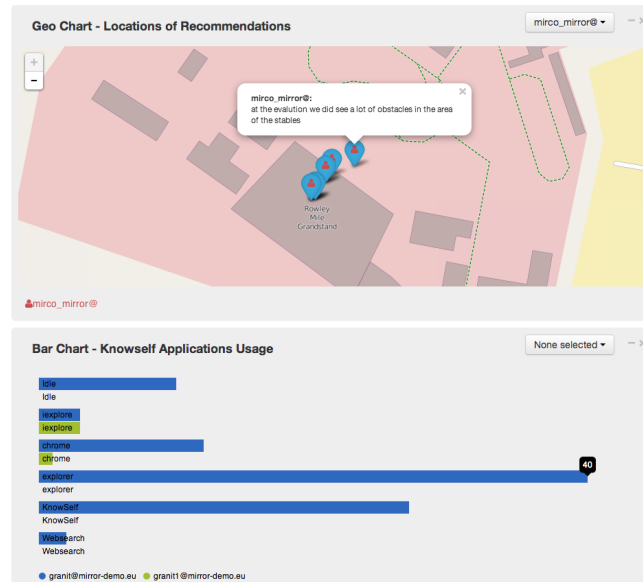


Fig. 4. Further sophisticated visualisations for the MUP App

7 Acknowledgement

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Reflection as Support for Career Adaptability: A Concept for Reflective Learning in Public Administration

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Abstract. Reflective learning is a mechanism to turn experience into learning. As a mechanism for self-directed learning, it is critical for success at work. This is true for individual employees, but also for teams and whole organizations. Change processes are typical situations in which people question their practices, reflect on how they adopt new practice and try to learn from good or bad practice for future work. Such changes can support the development of expertise. In cases involving substantive changes in work roles and behaviours they may even contribute to a process of professional identity transformation, which leads to a deeper understanding of one's own practice and of the processes involved in adapting it to internal and external constraints. Public administrations are examples of organisations that undergo constant change due to changes in legislation, financial pressure and demands of the public, and the public intensively observes them. These pressures are requiring staff to adapt, including by changing their professional identities. Integrating reflection into the practice of staff can support them in informal learning and improving, and it can thus lead to enhanced and more efficient services for the public. In this paper, we report on an approach of using reflection in Public Employment Services (PES) in Europe, which are currently being transformed from being principally concerned with administration of benefits and provision of advice and guidance to an increasing concern with coaching clients and co-operating with employers.

1 Introduction

Reflection is a common and desirable process of *learning from experience for future work* [1–3], which is carried out by individuals or groups in a self-directed manner and as a mostly informal learning process [4–6]. Reflection helps workers to deal with changing work contexts [4], supports them to create innovative practices [7] and enables them to create change in a bottom-up process [6]. Besides daily problems, upcoming and continuous change processes are typical examples in which people question the way they work(ed) and whether they have adopted new processes adequately.

Public administrations are typical examples of organizations facing constant change, due to: legislative changes, budget and staff cuts, requirement for remaining

staff to become more efficient, the public demand for higher service quality, role changes for staff, and, in some cases, alternative service provision (e.g., [8]).

Our work focuses on *Public Employment Services* (PES) as an example of challenges faced at public administrations: staff are dealing with more clients in a rapidly changing labour market and are expected to offer a wider range of services. In many European countries staff roles are being transformed from offering advice on access to benefits and available job opportunities towards facilitation and coaching where staff are expected to support clients in becoming more self-directed and staff are also expected to understand the labour market better and engage more with employers. Staff therefore need to be capable of adapting to various and often unforeseeable changes. *Career adaptability* [9] as a process of continuously adapting to changing requirements on the labour market is a central concept in this context. This process is closely connected to self-reflection and reflection in groups [9], but work investigating reflection support tools for career adaptability is not available. This paper connects research on reflection support to career adaptability research by presenting a conceptual approach and a prototype to support this process with reflection tools.

2 Related Work

2.1 Career Adaptability and Professional Identity Transformation

Career adaptability is the ability to manage successful transitions in employment, training, education and other contexts. It is key for workers dealing with constantly changing requirements on the labour market [9]. Adapting careers, however, needs a transformation of one's individual and collective *professional identity*, including aspects such as work activities and organisation, relations to other professions and professional culture [10]. This transformation can be triggered by challenges at work and needs self-directed learning, self-reflection and learning in interaction with others [9]. Therefore support needs to include individual and collective means.

Public Employment Services (PES) practitioners deal with career adaptability both in their personal careers and in the careers of clients they are supporting. Therefore supporting them in career adaptability not only supports their personal career but also supports their clients to re-enter the labour market.

2.2 Reflective Learning at Work

Following Boud (1985) [1] we understand reflection as a process of *conscious re-evaluation of experience for the purpose of guiding future behaviour*. This perspective is in line with the conception proposed by Schön (1983) [3], who in addition differentiates between reflection-in-action and reflection-on-action, and other authors dealing with reflective learning. In addition, we understand work and learning as intertwined [3, 11], and therefore also work and reflection [12]: reflection transforms experience from work into knowledge applicable to the challenges of daily work and thus needs to be understood as a key process for informal learning at the workplace [5]. It is

mostly triggered when individuals or groups perceive some discrepancy, e.g. contradictory information, incongruent feelings, interpersonal conflicts and other occurrences during work, leading to a state of discomfort that the individual or group wants to overcome [13]. Characteristic activities of reflection can then be found in asking for feedback on your work and opinions, critical opinion sharing (and being open to it in the organisation) or challenging groupthink (instead of going with the majority) [14].

In addition to most models we differentiate between *individual reflection* as a mostly cognitive activity and *collaborative reflection*, which is done in communication among peers in a group [15]. The latter has been found to create results that transcend the capabilities of a group's members [7] and it is a promising process for the creation of innovation and change in modern workplaces [4], but it has received less attention in work on reflection at work. Knipfer et al. (2013) [13] point out that as workplaces provide individuals with a social context, individual and collaborative learning are intertwined and must be considered together.

It has been shown that reflective learning can be supported by technology (e.g., [15–17]) by providing data or written content on experiences to reflect upon, supporting retrospective analysis or by scaffolding the reflective process, the documenting and sharing of a decision rationale. More specifically, writing down positive or negative experiences and being prompted regularly to think about them has been shown to be supportive for individuals to engage in continuous reflection [18]. However, as most existing work either supports early phases of reflection (e.g., gathering and sharing data) or stems from educational settings, which are often designed in favour of reflective learning, there is still work to be done in the context of reflection at work.

3 Reflection for Professional Identity Transformation: A Concept

The development of career adaptability relies on four key dimensions: learning to adapt through challenging work, through updating a substantive knowledge base, by being self-directed and self-reflexive as well as learning through interactions at work [9]. In this section we show how reflection can support these dimensions and how this can be used as a basis of professional identity transformation.

Dealing with *challenging work* can bring up discrepancies in daily work, which (as described above) trigger reflection [13]. Successfully dealing with these situations can lead to confidence in one's skills and abilities. Reflecting about work and its challenges comes into play when there are no problem solving patterns available for the challenges met and new solutions are needed [19].

To keep up with knowledge in changing fields of work learning through *updating a substantive knowledge base* is required. While workers often use formal learning offers at work, informal learning can be seen as a key to continuously understand which knowledge is needed and integrate it into one's context [9]. Reflection can support these needs [5] and the integration of new knowledge [20], helping workers to think about the state of their own knowledge and to identify learning goals, reviewing existing goals and periodically checking whether they are met or need to be altered.

Adapting through *self-directed learning* and *self-reflexiveness* is closely related to *individual* reflection. Tools can help to sustain issues to be reflected upon and to create awareness for them [12, 18]. This combines self-directed and externally triggered reflection, for example by setting up and periodically reviewing career goals in a tool.

Career adaptability by learning through interactions at work can benefit from support for *collaborative* reflection. Tools can help to create opportunities for reflection even if individuals cannot meet in person [15]. Individuals can support informal learning of their peers by providing their experiences and insights or helping them to reflect about their own learning. Additionally colleagues can reflect to support each other, for example, in coping with emotional work and/or stress and in exchanging best practices in dealing with difficult situations. A team can reflect collaboratively to improve their team performance and organize their learning efforts.

4 Applying the Concept: Reflective Learning Needs in Practice

Our work is inspired by field visits, workshops and expert interviews at different European *Public Employment Services* (PES) agencies, including Germany, Slovenia and the UK. In an early phase of this work we are currently exploring needs and opportunities for reflective learning as well as constraints and potential of implementing it in such workplaces. From this work we describe examples of challenges faced in many European PES and how reflection can be a key process in tackling them.

4.1 Supporting Change by Reflection on Training

In one of the agencies (referred to as agency A in this paper) staff are supposed to change from providing advice and guidance to clients on benefits and job opportunities to coaching them to become more self-directed and to take responsibility for their own future by proactively looking for ways to develop their skills and possible future career paths. To support this change staff receive a two-day training on coaching methods and related topics and an additional half-day session some time after training to support the application of the methods in practice. Despite this support, staff members reported that they had difficulties in implementing this new way of working, and that they were struggling in reaching good results from coaching their clients.

This situation is an example of challenging work, and it shows how workers struggle with updating their personal knowledge base. Reflecting on their practice of using methods and tools of coaching can help PES practitioners to conduct more successfully the transition to be a coach and thus may make training more sustainable. This may approach mostly benefits from *individual* reflection of goals stemming from training and involving workers in this reflection continuously (by reminding them to reflect).

4.2 Supporting Interaction with External Stakeholders by Reflection

In agency B the government requires PES staff to cooperate closely with employers to enhance the conditions of the labour market, including the creation of new jobs, new

fields of employment and career opportunities. Staff are motivated to adapt to this strategy, but also told us that this does not come easy and that there is a need for good practices in implementing it. Some reported that talking to colleagues from other subsidiaries had given them insights into how they might improve this work.

Becoming a co-operator with employers can be seen as an example of challenging work, and from the feedback of practitioners we can see which discrepancies it causes. We can also see that there is a desire to engage in exchange with others to reflect on such discrepancies. *Collaborative* reflection on their work with employers can therefore be seen as a means to make sense of typical challenges in this work, to exchange work practices and to learn from each other.

5 A Prototype for Reflection Support

The scenarios above show that support needs for learning about challenges *Public Employment Services* (PES) practitioners face are diverse, and that support for sustaining experiences, reflecting upon them, sharing them and finding similar experiences need to be close to work tasks. To explore how such support can create impact in PES agencies we created a mobile prototype supporting the reflective learning scenarios describe above. Using mobile devices makes support independent from corporate IT infrastructures (which are usually hard to access away from the office in PES) and enables users to use the tool when and where they want, for example after talking to employers or after work, e.g. while using public transportation on the way home.

In the prototype users can write personal notes about experiences at work (upper part of Fig. 1) and they can enter reflections multiple times about these notes (bottom part of Fig. 1), including an assessment of how they feel about the experience (see the smiley icons in the bottom half of Fig. 1).

The prototype also includes an easy to use sharing feature to enable *collaborative* reflection. To enhance personal engagement in collaborative reflection, when sharing content with colleagues the system offers users the opportunity to choose from predefined questions (or create a new question) to share together with the content. This aims at provoking reflection: For ex-

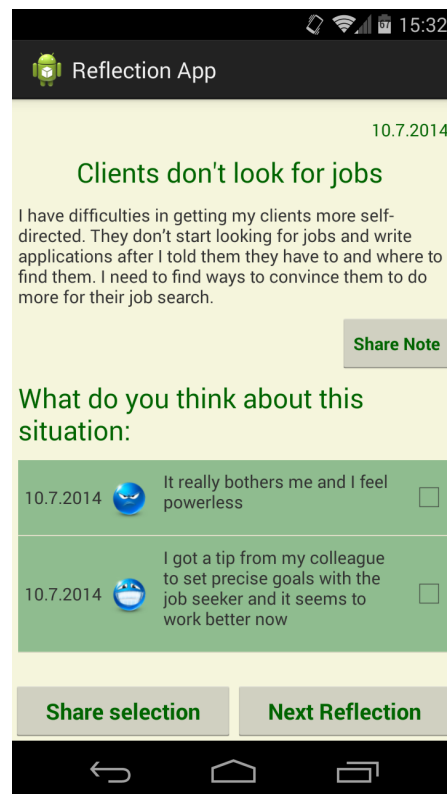


Fig. 1. The prototype allows users to write notes and to reflect on them. All notes and reflections can be shared.

ample, as user might choose a question such as “Did you ever encounter a similar situation? What did you do?” when sharing the description of an issue. This may personally impact colleagues, who feel personally invited to engage with the user sharing the content and motivated to help her. This may help to establish communities of practice helping each other and it facilitates collaborative reflection by engaging users in conversations about *challenging work*.

The tool periodically prompts users individually or collaboratively to revisit past issues and reflections. This can be useful to capture changes in perspectives on experiences over time and the resulting insights leading to this change. For example, if a user from agency A experiences she cannot implement a certain aspect of the new coaching process, she may improve over time, also rating this experience more positive after some time (see Fig. 1). It is also possible just to share one of the newer entries of a reflection with another user to enable collaborative reflection on specific aspects of the evolving situation. Using the tool in this way builds up an individual and collective knowledge base on aspects related to career adaptability.

Users control when they are prompted for reflection: they can let the system (contextually) determine when to prompt them or they can set reminders to reflect. This for example can be used to notify a user while she is using the bus on the way home and wants to reflect on situations she had experienced that day. This supports *self-reflexiveness* as part of career adaptability.

The prototype provides novel features such as sharing personal questions with reflection content and periodically promoting users for individual and collaborative reflection, which are directed towards engaging with challenging work and to support career adaptability. Future work will also aim to integrate its features into existing tools in order to better integrate reflection for career adaptability into daily tasks.

6 Discussion and Outlook

We have presented ongoing work in supporting career adaptability in public administration workplaces by reflection support. Our work is in its early stages, and we have created a concept for such support, situated it in needs of learning in PES organizations as typical examples of public administration and showed its feasibility by implementing a prototype. Next steps will include using the prototype with groups of PES practitioners in different agencies and improving the support it provides. In the ARTEL workshop we would like to discuss the concept and how it may be improved.

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Boosting Informal Workplace Learning in Small Enterprises

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Abstract Where participation of small enterprises in vocational education and training decreases, it risks obsolescence of their knowledge base compared to competitors. Currently we are participating in two projects that aim to address the issue of how to boost take-up of informal learning at the workplace: Learning Layers and BOOST. Previous projects [e.g., ROLE] show the importance of having personalised learning solutions with high relevance, high effectiveness and low barriers to use. Therefore we aim to provide predefined and customizable Personal Learning Environments that support awareness and reflection of users, especially workers in small enterprises.

Keywords: Informal Workplace Learning, Personal Learning Environments.

1 Introduction

Support of informal learning at the workplace is real issue and we attempt to address it in two projects: Learning Layers [1] and BOOST [2]. While the first one is dealing with the problems of scalability and scaffolding, the second one is focusing on small enterprises (up to 20 employees) and their needs. Both of them build on the outcomes of the former ROLE project [3], especially the technological platform that facilitates design and development of Personal Learning Environments (PLEs) [4]. Moreover, BOOST considers innovative methodologies from the BeCome [5] project that identify the Business Goals of small companies and manage the associated learning processes. The PLEs provide customized learning and training solutions that enable to meet the specified Learning Indicators. The overall aim is to support employees in training activities and to facilitate their personal development. For this purpose we want to integrate learning in their work processes. We develop widgets that should support awareness and reflection of various types of users in practice. In this context it is crucial to consider specific constraints and requirements of small companies, in order to make the developed solutions attractive and useful for all different roles: managers, trainers and employees. Our solutions support personal competence development at the workplace in all phases, i.e. planning, learning, and reflection. They help to identify business goals and existing competence gaps. Moreover, they recommend learning resources from existing repositories and suitable peers in communities of practice.

2 BOOST Technical Prototype

Our proposed solution should support *awareness* by augmenting informal learning with relevant information of the business goals, current and target competences of employees, time plans, learning resources and learning progress overviews on various levels (e.g. company, employee). *Reflection* is an important part of self-regulated learning that helps the users to evaluate their progress and to plan the next steps. These features had to be considered in the BOOST technical prototype, which is still work in progress. It includes this basic workflow: 1. Identify critical business goals in the company. 2. Select employees to address them. 3. Support their learning. 4. Monitor the learning progress of the company and of the individual employees. Our data model is hierarchical: 1. Business Goals (BGs – e.g. Web development). 2. Learning Indicators (LIs – e.g. Web design, information architecture). 3. Learning Resources (LRs – including learning materials, tools and peers).

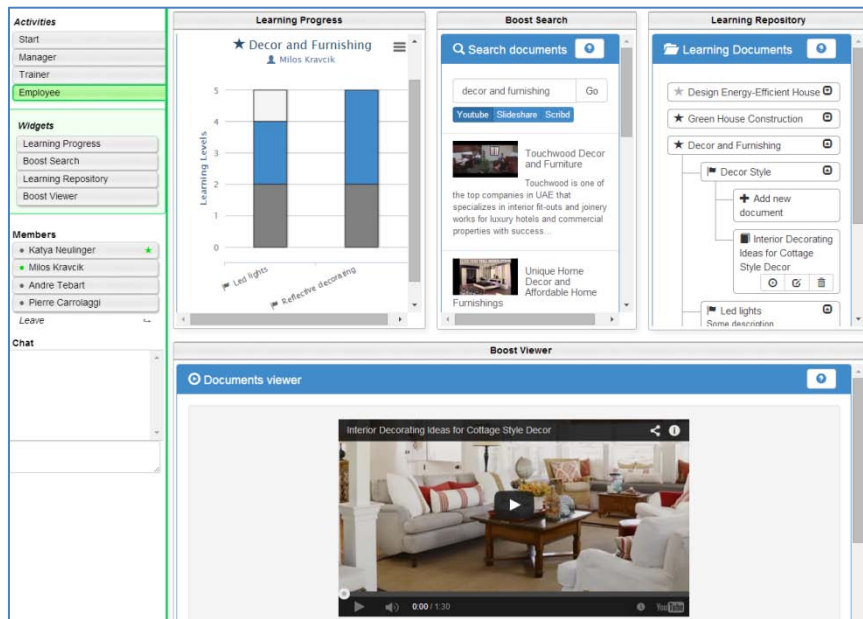


Figure 1: Employee Environment

We distinguish 3 different user roles that have different characteristics and requirements: Manager (e.g. business manager, business advisor or consultant), Trainer (e.g. training manager, learning facilitator) and Employee. *Manager* specifies BGs for the company, decides which BGs are urgent and which of them are relevant for which employee. Moreover, this role can also assess employees and monitors their learning progress. *Trainer* describes LIs for selected BGs and the relevancy of LIs for individual employees, recommends LR for the LIs, and chooses relevant Learning Repositories, where additional LR can be found. *Employee* (Fig. 1) gets an overview of BGs and LIs assigned to her, together with the recommended LR. According to

the descriptions of LIs she can search for additional LR in the predefined Learning Repositories and add them to her portfolio. She can also access the selected LR in order to learn. Finally, she can monitor her learning progress.

The functional requirements for competence management include: 1. Specification of relevant BGs (high level competences), their priorities and time scales. 2. Assignment of LIs (concrete competences) to each BG, considering also time scales. 3. Assignment of LR to LIs. 4. Assignment of relevant BGs and LIs to employees. 5. Setting up target LI (proficiency) levels for relevant BGs for each employee, considering time scales. 6. Assessment of the start and current LI (proficiency) levels for the employee. 7. Monitoring the training progress in the company and also of each employee (considering also time scales). The functional requirements for the learning support are still relatively vague, as they will be more domain dependent: 1. Community support – sharing experience, communication, and collaboration. 2. Domain specific support – learning and assessment. 3. Annotation of learning resources assigned to LIs. 4. Considering preferences of individuals.

3 Conclusion and Future Work

In the first year the BOOST consortium identified the main requirements and designed a solution. Afterwards we have developed the first version of the technical prototype, which has been evaluated in interviews with 15 stakeholders. Based on their outcomes the technical prototype will be updated and enhanced with additional features, including privacy requirements and personalization. The current version is suitable for companies with open environments, where employees do not mind seeing each other's competences and learning progress. But in many companies more privacy is demanded, where employee can see just his or her data. Another important feature is assignment of timescales to business and learning goals as well as their monitoring and notifications. The new version will be tested in companies.

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Activity Recommendation App – Software to Evaluate the Usefulness of Improvement Recommendations Created in a Team

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Abstract. The Activity Recommendation App supports employees in individual and collaborative reflection by capturing discussions and solutions for problems that need to be solved. The app enables employees to record personal experiences with the solutions. Based on these experiences the usefulness of a recommendation can be re-evaluated in order to approve, update, or discard the recommendation. The application was successfully evaluated in coaching employees in learning time management techniques.

Keywords: ARA – Activity Recommendation App · soft skills improvement · recommendation evaluation · solution · experiences · MIRROR Spaces Framework · time management coaching

1 Introduction

Reflection on work experiences can lead to new insights and ideas how to handle work situations better in the future. But the capturing of experiences during work and the reflection on this data is only half the way for a successful improvement. The other half is the creation of a viable reflection outcome and the validation of this outcome when it is applied in practice (see [1]). Based on this validation, a change can be approved, reverted, or improved and validated again.

Whilst a lot of applications support users to capture data during work in order to provide it in a subsequent reflection session, the second half of the reflection cycle is often left unsupported. To also cover this part, the Activity Recommendation App (ARA) was created in the MIRROR project [2]. It supports the discussion of improvement ideas in an individual or collaborative reflection session and frames the outcome as recommendation. The app allows capturing personal experiences relating to active recommendations and viewing other members' experiences if a recommendation targets a team. Finally, the ARA supports the evaluation of a recommendations' usefulness when applied in practice, in order to enable its improvement or suspension. By providing these features, the Activity Recommendation App aims to improve the application of insights gained from reflection on work.

2 Overview of the Main Functionalities

The recommendation is created in an individual or a collaborative reflection session. Major elements of this session are the identification of the concrete issue and a viable solution for this issue. Texts, files, or data from other MIRROR applications can be attached to be used as evidence to back the comprehensibility of a recommendation. The events during the discussion are listed as a kind of minutes. Measurement criteria can be selected to evaluate the usefulness of the recommendation. Before publishing the recommendation, a target person/group is selected and invited to try the new solution.

A concrete scenario could look like this (cf. [3]): A team uses ARA to find a solution for their common problem of overtime spent for pending projects. They agree that frequent interruptions can be one reason for this (*issue*). In the scenario the teams' solution is to implement three hours of quiet working time a day and to avoid interruptions during that period (*recommended solution*).

The screenshot displays the ARTEL14 application interface. At the top, there are three tabs: 'CAPTURE', 'MANAGE', and 'DISCUSSION'. Below these, there is a search bar and two dropdown menus for 'TYPE' and 'PUBLISHER', both set to 'All'. The main content area is divided into three sections: 'ACTIVE', 'ISSUE', and 'RECOMMENDED SOLUTION'. The 'ACTIVE' section on the left lists two items: 'empty e-mail inbox' and 'Introduce a "Casual Friday"'. The 'ISSUE' section in the center contains the text: 'My inbox is full, so I have no idea of which e-mails contain tasks and when these have to be done.' The 'RECOMMENDED SOLUTION' section contains the text: 'Every day, I will check incoming e-mails on content and create immediately tasks so that I can move the e-mails into folders and empty my inbox.' Below the solution, there is a 'CAPTURE EXPERIENCES' button and a 'MY EXPERIENCES' button. The 'MY EXPERIENCES' button is active, showing a 'RATING' section with five stars and a 'COMMENT' section with the text: 'Today, it worked well for me. Great idea!'. At the bottom, there is an 'EVIDENCES' section with the text: 'No evidences are attached.' and a 'SUBMIT' button. On the right side, there is a 'BEHAVIOR TASK' section with the following information: 'PUBLISHER: Susan Support', 'PUBLISHING DATE: 30. June 2014 - 11:51', 'MY PROGRESS: Active', 'LAST EXPERIENCE CAPTURED: 30. June 2014 - 13:52', and 'GROUP INFORMATION: Not one out of 4 persons solved this task.' At the bottom right, there are two buttons: 'MARK AS SOLVED' and 'IGNORE'.

Fig. 1. A recommendation in ARA with one experience being entered

To test the recommendation in practice, personal experiences are written down to decide about how well the recommended solution applied (see Figure 1). Users capture their experiences by noting down a comment and by rating how well the solution worked (1 to 5 stars). In addition they can record the effort (e.g., the minutes of working time required) and the benefit (e.g., the number of completed tasks) of applying the solution. These experiences are shared with the other members of the target group to benefit from the application in a group.

To evaluate a recommendation, the app allows users to view all experiences with an aggregation of the ratings, efforts and benefits captured. All this can then be used to get an overview how well the solution works in practice to be taken as a basis for the decision if the solution should be kept, updated or discarded.

In the continuation of the exemplary scenario, the team discusses the recommendation's weak points (due to the captured experiences) during the regular team meeting and agrees on adapting it in respect to the selected period in time. It is then re-evaluated, re-discussed, and finally marked as solved when team agrees about a well-functioning final solution.

3 Evaluation & Outlook

A summative evaluation of the ARA took place at our company IMC over a period of six weeks. Ten staff members took part in a time management coaching. The approach combined the usage of a computer activity tracking tool and the ARA with a weekly coaching session. In the weekly coaching sessions the coach and the coachee reviewed the individual progress, adjusted the time management rules if not appropriate anymore, or, when the particular goal has been achieved and the new behaviour has been adopted, decided that no further practice regarding that goal is needed.

The Activity Recommendation App served well as a support for learning time management by providing a data basis for the coaching sessions. It was used by coach and coachee to set time management goals and to document and monitor the progress in learning new time management techniques. Both benefited from the better preparation for the coaching sessions available with the notes in ARA. Furthermore, the app helped the coachees to focus their goals. Two things were missed concerning ARA: It lacks an interface optimized for smartphones and currently no reminder function is available which motivates the user to capture experiences. These shortcomings can be addressed in future development.

The coach and several coachees also suggested forming peer groups to train time management techniques. They could then benefit from sharing experience data to compare own progress with that of others and learn from each other's experiences. IMC has started a free online course for time management that includes usage of the ARA [4]. In addition to the course, learners can book a human tele-coach for a fee.

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DDART: an Awareness System to Favor Reflection during Project-Based Learning

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1 Introduction

Our research aims to improve learners' reflection and self-regulation in Project-Based Learning (PBL). Actually, we observe that the implementation of PBL in engineering schools, universities or professional training do not benefit from all its capacities, because it is often action (according to the Kolb's learning cycle) which is favored to the detriment of reflection and personal experience [1]. Our approach considers Self-Regulated Learning (SRL) as a major component of PBL to bring learners to self-reflect on their experience and to apply metacognitive skills.

We focus our work on the design and the development of a dashboard based on both reporting and activity traces [2]. The activity traces are automatically produced by the users' actions and recorded directly by the LMS during the learning activities. The reporting traces are information reported by the learners themselves. Most dashboards use only automatic activity traces to produce indicators. We state that the aggregation of these two types of traces allow producing more meaningful indicators for the learners [3].

Most existing dashboards are designed for the tutors to monitor the learners but they are rarely designed for the learners to support awareness during their activities. Furthermore, the indicators are mostly predefined and the users can rarely build their own indicators [3]. In this paper, we present the DDART system, which is composed of two specific tools: a reporting tool that aims at enhancing learners' reflection during project-based learning and a tool to help learners to produce their own indicators for enhancing awareness during their project. These two tools are integrated into a same system (DDART) to enhance learners' self-regulation thanks to personalized indicators presented on a dashboard.

2 A reporting tool and a dynamic dashboard

We developed a Dynamic Dashboard Based on Activity and Reporting Traces (DDART). We chose to implement this dashboard as a plug-in of the Moodle platform. In our context, project members use the Moodle tools (wiki, forum, chat...) to

The semi-structured sentences of the reporting tool (reporting traces) and the traces of use of Moodle (activity traces) are respectively recorded in an XML database (BaseX) and in a relational database (MySQL). These two kinds of traces are described according to the same five common entities: Learner, Tool, Activity, Time and Place. They are merged according to a common time basis and are stored into a transformed traces base. The transformed traces are used to produce indicators stored in a dedicated database [2]. An indicator is defined by 5 parameters:

- X entity and Y entity: these parameters can be chosen by the learners among the instances of the five entities extracted from the transformed traces (Learner, Tool, Activity, Time, Place). These entities are used to specify the events the learners want to observe.
- Value: this parameter sets the type of aggregation proposed to produce the data presented into the indicator. Four possibilities are proposed: frequency, time interval, time spent, content.
- Calculation function: the learners can refine the analysis of values by defining other mathematic formula based on sum, difference, comparison and average.
- Visualization: DDART offers eleven visualization modes for learners (pie chart, bar chart, line chart, gauge chart, social network, scatter chart, area chart, table, tree map, combo chart and Gantt).

3 Conclusion

In this paper, we have presented the basis of the DDART system. This system can help learners to collect, analyze and visualize their reporting and activity traces in the form of meaningful indicators. By allowing learners to create their own indicators, we aim at making them learn how to regulate their learning activities. The traces collected in the reporting tool allow the construction of advanced indicators that can help learners to build metacognitive skills. For example, the indicators can support the analysis of behavior by comparing the learners' feeling about their activities (subjective) with the realization mode of the activities (objectively recorded by the system).

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LARAE: Learning Analytics Reflection & Awareness environment

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Abstract. Exploring and managing the abundance of data that Learning Analytics generate is a challenge for both teachers and students. This paper introduces a Learning Dashboard that provides an overview, context and content of learner traces to help students with awareness of feedback and progress, and assist teachers with monitoring student effort and outcomes to intervene where needed.

Keywords: learning analytics, learning dashboards, awareness, information visualization, effort, intervention, inquiry-based learning

1 Introduction

The purpose of Learning Analytics is understanding and optimizing learning and the environments in which it occurs [1]. Through dashboards, Learning Analytics can help support both teacher and students [2].

Learning Dashboards can rely on many different ways of visualizing raw analytics data e.g. bar, star and bubble charts, interactive histograms, parallel coordinates etc [2]. These visualization techniques can provide broad insights on student activities [3, 4]. By adding teacher traces, our visualization also attempts to provide awareness of feedback to improve its supportive role for both student and teacher.

This abundance of data can be abstracted to the essentials [5, 6], but context and content can help provide deeper insights [7]. Following the visual information-seeking mantra of “Overview first, zoom and filter, then details-on-demand” [8], our dashboard presents users with an abstract overview while still retaining a sense of context and providing access to the details.

2 LARAE: Design & Implementation

LARAE visualizes traces gathered from 38 engineering students, teachers and external participants in an open User Interfaces course. Students worked in groups of 3 and reported weekly through blog posts, comments and Twitter. The course generated 419 blog posts, 1580 comments and 538 tweets.

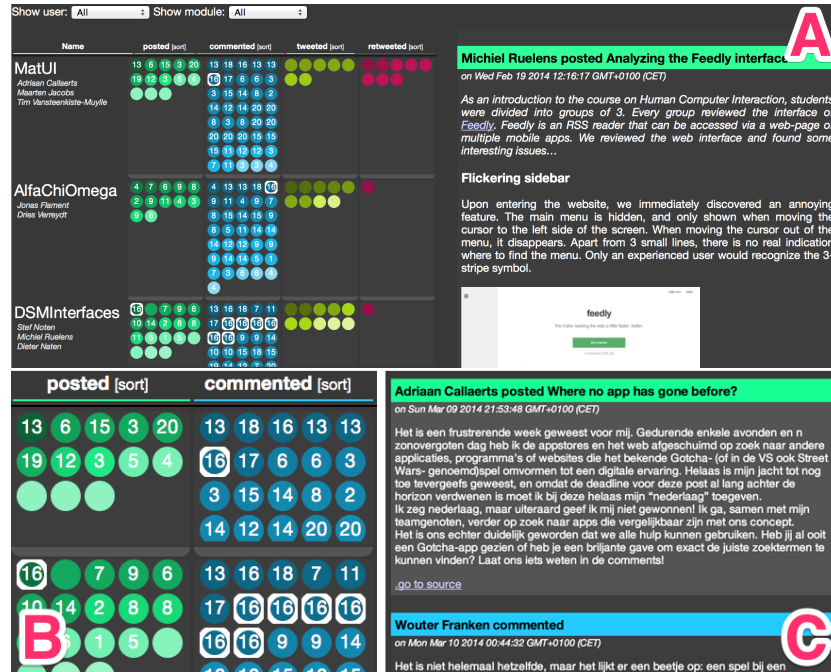


Fig. 1. LARAE: A. Overview, B. Activities, C. Thread view

Every activity is represented by a circle (Figure 1.B) which provides direct access to the related content (e.g. blog post, comment, tweet, retweet). Activities are sorted chronologically, from top left to bottom right. Gradient color values (see Figure 1.A) help recognize the age of an activity. A table (Figure 1.B) structures the activities by student group and type. Every column represents an activity type, every row a student group. The user can sort the data by any activity type. Both activity age and amount help facilitate awareness of (in)active groups. As teaching staff feedback was deemed important by both student and teacher, a second table visualizes activities of teacher activity in a similar way.

Context plays an important role in understanding the activities e.g. a comment without its surrounding discussion is difficult to assess. We propose a “focus+context” [9] solution which consists of 2 parts: highlighting related events (Figure 1.B) and displaying the content within a thread view (Figure 1.C).

Highlighting related activities helps the user to instantly become aware of the distribution of an activity thread across the class e.g. selecting a blog post will highlight what groups provided most contributions. Simultaneously, the thread view shows the content of each related activity, helping assess the quality of the quantitative data. Visualizing discussion thread size can help students discover interesting threads. Teachers might understand low thread size as an indication for need of intervention. The attribute thread size is indicated by a number in each circle (Figure 1.B).

LARAE is a web application developed using HTML5, JavaScript and D3.js¹ running on a Node.js² web service and MongoDB³ database. It supports both the proprietary API and Tin Can API⁴. It can easily be extended to support other APIs. The dashboard is designed to run on large displays, desktop computers and tablets. It is available at <http://ariadne.cs.kuleuven.be/LARAE/>.

The dashboard has also been deployed in an inquiry-based learning setting, visualizing the learner traces gathered from the weSPOT Inquiry system⁵ [10].

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